FIRE SAFETY IN MULTI-FAMILY HOUSING

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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HOUSE OF REPRESENTATIVES

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FIRE SAFETY IN MULTI-FAMILY HOUSING

THURSDAY, JULY 28, 1988

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Science, Research and Technology,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:40 a.m., in room 2318, Rayburn House Office Building, Hon. Doug Walgren [chairman of the subcommittee] presiding.

Mr. **Walgren.** Well, let me call us to order and open our hearing today, and I, at the outset, as a matter of form, get unanimous consent that any cameras and recording equipment that the press or others would like to engage in this hearing be permitted, and, without objection, that will be the order.

I want to welcome you to a continuing interest of this committee in discussing and pursuing fire safety. I can't think of this area and the kind of losses that we have in the United States and the issues that are brought into play without thinking of that game show that used to be, I guess, called "You Bet Your Life," and that's exactly what we do in this area in view of the losses that the United States suffers. Industrially, when we compare ourselves to other industrial countries, we suffer the highest loss rate per capita in the world, and that is simply a state that is absolutely unacceptable.

Fire is often overlooked as a national tragedy. It claims 6,000 and more victims each year, largely one by one or two by two. They are mainly very young or very old, and they are often in the privacy of their own home. The statistics bear out that there is no place like home for fire fatalities. The fact is that, annually, over 80 percent of all fire fatalities occur in homes. Almost 14 percent of these fire fatalities, or somewhere in the range of 700 lives, including almost $500 million in property loss, occur in apartments and buildings that are multi-family.

This hearing on fire safety in multi-family housing is, as I said, a continuation of this subcommittee's interest and our commitment to improving fire safety. The concern for fire safety has grown out of our jurisdiction over the U.S. Fire Administration, the National Fire Academy, and the Center for Fire Research, all of which were created in 1974 by the Federal Fire Prevention and Control Act of 1974, the first major step on the Federal level into the fire area.

As a result of that jurisdiction, in the last seven years this subcommittee has held hearings focused on fire fighter health and safety, on fire fighter training, on public education, on hotel fire safety, on fire data research, and on fire engineering research.

The subcommittee has been made aware that a controversy has erupted over whether codes for multi-family housing have become too lax, including the likelihood of fire spreading between units of multi-family housing. The Federal Government withdrew from this area in 1984 when the Department of Housing and Urban Development abolished its code for multi-family units built with Federal funds and essentially deferred to local codes in the area.

Currently, local codes may require lower fire ratings for walls, essentially the amount of time a fire would have to burn to breach a wall, than the Federal code did and may allow the ratings to be achieved with different materials or may allow tradeoffs lessening the protection in return for the installation of different kinds of fire protection controls, such as sprinklers or other safety devices.

This hearing will focus on issues such as, how do we balance the risk reduction and the cost when determining a reasonable level of safety for multi-family housing and related fire safety codes? How do we assess the role of the Federal Government in determining fire safety in multi-family housing, particularly those for which we have a direct responsibility because they are built with Federal funds? Finally, it certainly seems that our technologically advanced country should be able to make the residences, and particularly multi-family housing, safe from fire.

Answers to this problem may not be cut and dry or simple, and yet clearly the technology does exist to improve fire safety in homes, and we as a country cannot afford to ignore this kind of issue because so much is at stake.

With that, I'd like to recognize the ranking minority member of the committee, Congressman Boehlert from New York.

Mr. BOEHLERT. Thank you, Mr. Chairman.

Fire is the forgotten killer in America. When we think of hazards, our minds turn to modern sounding destroyers: viruses, chemical pollutants, psychological distress. Surely such an elemental primitive danger as fire poses no threat to us. It is exactly that attitude, of course, that explains why the United States has the highest rate of loss of life and property due to fire in the industrialized world. Let me repeat that. The United States has the highest rate of loss of life and property due to fire in the industrialized world. Ignoring fire doesn't make it go away. Quite the contrary.

There are three steps we need to take to make the fire problem go away: prevention, suppression, and containment. This subcommittee has expended much time and effort on the first two of those steps. To promote fire prevention, we have fought hard to maintain funding for the U.S. Fire Administration and the Center for Fire Research which develop and publicize fire prevention methods. These agencies are vital to our efforts to combat fire.

To improve fire suppression, we have supported the National Fire Academy and have fought to maintain the travel stipend program that makes its on-campus programs accessible to all fire fighters. We are also continuing to press and press hard for our bill, H.R. 3704, which would encourage hotels to install a simple, affordable fire safety device, the sprinkler. There is no excuse for hotels not to provide this basic protection to their customers. Yet even the hotel industry's most optimistic survey shows that fewer than half the Nation's hotel rooms have this equipment. Other surveys have suggested that as few as 15 percent of the Nation's hotels and motels may have sprinklers. Our bill will change that.

So today we turn to the issue of containment. Among the questions before us are: What materials adequately contain fires? Do our fire codes accurately reflect our knowledge of fire containment? Are we sacrificing fire safety for financial savings?

It may seem odd that the Federal Government would concern itself with these problems. After all, code making in this country is, and it should be, primarily the province of voluntary associations and the States, but that does not mean the Federal Government has no role to play. The Federal Government has the opportunity and, I think, the responsibility to be a leader in fire safety, to protect American lives and property. Federal buildings should be models of fire safety, and buildings constructed with Federal funds should be held to a very high standard. The Federal travel dollar should be spent only in fire-safe accommodations both to protect Federal workers and to encourage increased fire safety.

The Federal Government does not have the option of being neutral on fire safety. The way Federal money is spent is the Federal position on fire safety, and it ought to be examined. "Do as I say, not as I do" is lousy fire prevention policy. Unlike those modern sounding hazards, the protection of Americans from fire does not require enormous expense or endless research on high-tech equipment, it simply requires political and personal will.

Thank you, Mr. Chairman.

Mr. **WALGREN**. Thank you, Mr. Boehlert.

Let me introduce our first panel to join in these discussions: Clyde Bragdon, the administrator of the United States Fire Administration; Dr. Jack Snell, the director of the Center for Fire Research at the Bureau of Standards; and Mark Holman, the director of Manufactured Housing and Construction Standards Division with the Department of Housing and Urban Development.

We appreciate your joining us today, gentlemen, and written statements that you would like to make will be made part of the record, without more ado, and you can feel free to underscore or emphasize points that would stand out and should stand out more directly in the oral discussions. So please feel free to proceed as you would like.

The gentleman from New York.

Mr. **BOEHLERT**. Mr. Chairman, I just would like a brief explanation for all of our panelists and our visitors to this morning's important hearing. At 10 a.m. today, the House will go into session to consider the emergency drought legislation. We have got our Nation's farm community in crisis, and we're trying to respond to that crisis. That explains why you have slim attendance from this side of the witness table, and from time to time I'm going to have to leave too, because I'm very much a part of a very important section of that drought relief package, trying to help America's dairy farmers.

So I want you to understand that this subcommittee, the chairman and the ranking member and all the members, are deeply concerned and interested in this issue and in this hearing, but that explains why we have the slight attendance on the panel here.

Mr. **Walgren**. Well, with that let's turn first to Mr. Bragdon, and we'd be pleased to hear your statements, and we'll go through the panel and then have some discussion.

Mr. Bragdon.

STATEMENTS OF CLYDE A. BRAGDON, JR., ADMINISTRATOR, U.S. FIRE ADMINISTRATION, FEDERAL EMERGENCY MANAGEMENT AGENCY; JACK E. SNELL, DIRECTOR, CENTER FOR FIRE RESEARCH, NATIONAL BUREAU OF STANDARDS; AND MARK W. HOLMAN, DIRECTOR, MANUFACTURED HOUSING AND CONSTRUCTION STANDARDS DIVISION, OFFICE OF HOUSING, DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Mr. **Bragdon**. Thank you, Mr. Chairman. My name is Clyde Bragdon, the administrator of the United States Fire Administration.

Mr. Chairman and members of the committee, I do understand the dilemma that you are facing, recognizing that one of you from the rural area does have dairy farms and there's not many in the city of Pittsburgh. However, I'm pleased one more time to appear before you again. I think my last appearance I described as perhaps my swan song before this committee in the past opportunities we've had.

I would like to initially commend you for one more time providing a forum and affording the opportunity for the several interest groups that impinge upon the fire protection problem within this country to have a dialogue with each other and in public forum, and I think the end result, a product that comes from this, will serve our citizens even better than we have in the past.

We recognize that there are issues between the various elements that serve the fire protection problem in this country, and it's appropriate that they be aired, discussed, and maybe compromise where it is appropriate and necessary so that our citizens will be served.

It would be best to perhaps start off by saying I have submitted the appropriately sanitized version of my testimony for the record, but I will not utilize that and will more informally try to describe and address the issues before us today.

Mr. **Walgren**. The committee appreciates that very much, more than we can say, and we should note that it's tough to get members of the administration many times to testify candidly and without looking over their shoulder as to whether or not there's some higher up that would be looking askance at what they said. But the issue of safety and the lives that are involved literally commends your approach, and we have appreciated it in the past. You will go down with singular credit in terms of the witnesses that come before this committee.

Mr. **Bragdon**. Thank you, sir.

Mr. **Walgren**. Please proceed.

Mr. **Bragdon**. I want to reinforce your opening comments relative to describing the fire problem on a narrow sense, I guess, as we address the multi-family housing and multiple-unit housing within this country.

You did appropriately describe using the NFPA, the National Fire Protection Association's, estimates of where we currently are in terms of loss and in terms of lives lost, which seems to be a measurement criteria that's frequently used as we describe fire. But I think at the same time we should describe the progress that has been made in the last decade through a series of events and activities and attention to the issue. I think it can be appropriately stated and authenticated that we have literally reduced fires in this particular occupancy classification by literally one-half in the past decade, and we give recognition to the fact that a lot of data will be utilized in testimony this morning, but I again would warn people to put that in proper perspective, that it's being utilized to reinforce a position and interest or if, in fact, it reflects what we're here to talk about, and that's life safety.

We recognize that we did not have a sophisticated data collection system in past years, that much was done through the estimate arrangement, and that we were dealing with inflated numbers, but those numbers have all fallen pretty much into place through the system that's used by the National Fire Protection Association in support of the National Fire Information Reporting System. So we are dealing now with some appropriate and hard data.

Now what does "data" really mean? It just gives us some reflection of what's happening on the national and local scene. It allows us to dedicate our limited resources in that direction. It does give us some attention as to what we should be and where we are going.

We talk about the fire problem in that particular occupancy classification. The data would indicate, obviously, that it is a downward trend. We also would say that in the residential occupancy as a whole it's fairly well stabilizing, that the initiatives of the past have performed well to this point, and that we need something to kick it off this particular plateau and move on.

Many would not describe fire deaths of 6,000 in this country, about 80 percent of which are in the residential occupancies, as being a significant problem, particularly when we deal with some of the other national social and economic issues that affect us. But those of us who have dedicated our lives to this particular problem feel it is significant, and we are pleased to have been part of a program that has seen major reductions over a period of time, and we want to continue to be part of a program so that we ultimately can have a fire-safe America, because the data that you related in your opening statement indicates the most sophisticated technologically advanced nation in this world can do better. And how can it do better?

Well, I think I would like to describe how we feel as an official position of the U.S. Fire Administration addressing the fire problem. Number one, fire is caused by—primarily by human behavior, and we need to continue and advance and expand the altering of that behavior; 80 percent of our fires are attributed to some human act. So public education and awareness, which has been neglected primarily for a long period of time in this country, needs to move into our communities.

When we make comparisons with a foreign environment, we find that is the essential difference. Their housing is more vulnerable than ours, their practices are more vulnerable than ours, and yet there is an attitude that prevails in their communities in foreign countries that does not here. That may be a consequence as much, if anything, that we in government and the private sector over too long a period of time, through insurance and other factors, have "We'll take care of everything" business. As has been frequently stated for those who have burned out, "My insurance company really paid off and took care of something," even though you were the cause, through accidental or other means, of that fire. So we have a long ways to go in addressing human behavior.

Those are things, of course, that are most difficult, but I believe that's the most appropriate investment that we can make in our future to alter the course of action on our fire problem. But the fire program, of course, has to be put in its proper scope, and again I want to emphasize that one should be required to qualify the data that they utilize to justify positions.

Other advances that have been made, I think, are in the codes and standards area in the last decade or so, and that's part of a continuum, and we see that progress being made. When you talk about multi-family housing, it does not have the same aura that you would apply to single- and two-family housing relative to enforcement requirements and subsequent inspection over a longer period of time so the public does pay more attention, and still greatly lacking in that area, public agencies, to the inspection responsibility that you will not find in the single-family environment.

The advent of the smoke detector—very minor and very insignificant as far as cost—event, I think has been a major contributor, obviously, to early warning, allowing people to report fires sooner and certainly escape from potential tragedy. I think that's been a major contributor to the effort.

Sprinkler systems: As you well know that we have had a strong initiative over a period of several years in trying to redirect the technology that has been served so well in the property protection area for nearly 100 years, or over 100 years, and to research it, redirect it into the residential environment.

A fire that's put out in its incipient stages is not a fire of consequences, and as more than 400 jurisdictions within this country have introduced one form or another of residential sprinkler protection I think our data will start demonstrating more and more through the case study the effectiveness of this technology in that particular environment.

We also have to understand there has been a change in the furnishing environment that's taken place and this long time before there's a transition made of our furnishings, but voluntary standards by their industry are making furnishings more fire-proof. We have States such as California that have a mandatory standard. So that goes to any upholstered fabrics which have been contributors to the problem. And certainly the single one thing that's served us well for many years is separation. Separation can mean distance, and much of our zoning and property laws are based on separation because of fire-spread problems that have a historical significance with particularly our major cities in this country right now, as we move things closer together, to have separation within the walls themselves.

What I have described to you, of course, I think is what I—what we like to call—is a systematic approach, a balanced approach to fire protection, that no single piece of hardware, no single technology, provides everything, that with proper balance, and within that dialogue that takes place, compromise is obvious. There is room, and not room to accommodate interest but room to accommodate and address the fire problem, for all of these elements to be present. I prefer to have, if I were living, some redundancy in case there is a system failure; don't put all your eggs in a single basket.

Therefore, we must talk in terms not of fireproof buildings. I in the past, as you have as well, have seen many burnt-out structures with writing on the side "Fireproof hotel." The contents and the human factor are not fireproof. So that's only one element. The building still stands.

We need to also address this within the framework, of course, of one of the major problems in this country, and that's affordable housing, that we are not running things out of range and so forth. There has to be a continuing kind of dialogue to address these issues.

We are pleased, of course, from our perspective, to see what the major code groups have done within the past year and to see as recent as this week with the action of the Southern Building Congress having amended into their standards as well a proposed amendment that multi-family housing and hotels will, over the same basis of Building Officials & Code Administrators International, Inc., (BOCA) and the International Congress of Building Officials have done with the uniform building code, force sprinklers in hotels and multi-family housing, with some qualifications, not complete, but major and significant progress that we are adding another protection element.

Obviously, there is some concern, and appropriately so, that has to be addressed relative to what has been described as tradeoffs. I would rather call them alternatives because the word "alternatives" has been in our codes for years and not the word "tradeoffs," that the fire official, the building official, has had the flexibility to look at other alternatives that will perform and get the same end result.

Anyway, those are some of my opening comments as to how the U.S. Fire Administration's position is relative to the fire protection problem in multi-family housing, and I would like to again repeat, if we continue this dialogue and if the interest groups are able to provide some movement with each other, that we can have ultimately a fire-safe America.

Thank you.

[The prepared statement of Mr. Bragdon follows:]

STATEMENT OF

CLYDE A. BRAGDON, JR.

ADMINISTRATOR

UNITED STATES FIRE ADMINISTRATION

FEDERAL EMERGENCY MANAGEMENT AGENCY

BEFORE

THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

JULY 28, 1988

Mr. Chairman, I am Clyde A. Bragdon, Jr., Administrator of the United States Fire Administration (USFA). It is a pleasure to appear before this Subcommittee to discuss the subject of fire safety in multi-family dwellings.

The United States Fire Administration believes that many viable methods for fire protection are available to local officials charged with the authority of protecting the lives and property of citizens from fire. Three of these methods I will discuss in some detail today.

The most economically viable and cost-effective level of fire protection can be achieved when local officials are free to develop and implement a systems approach to fire protection which incorporates and combines methods of fire protection to achieve results acceptable to their communities. Local officials are in a unique position to prescribe a system utilizing nationally recognized codes and standards which will meet the objectives of their communities in the areas of economic and community safety. It ought to be the function of the Federal Government to aid these local officials in discharging their responsibilities by furnishing timely and accurate information about system performance.

In the event of a fire, it is of paramount importance to hold the fire in check and to limit its growth until evacuation of the occupants can occur and until fire suppression forces can move into position to attack and suppress the fire. The objective of holding the fire in check and allowing for safe escape of the occupants can be achieved in a variety of ways.

The occupants may be alerted to the presence of fire when the fire is small and the level of threat to the occupants is still low by means of a properly installed and maintained smoke detector. These devices generally afford ample time to achieve evacuation and to alert the local fire department before the fire grows to a level that threatens the loss of life and structures. The reduction of life loss due to fire that America has achieved in recent years is in great measure due to the presence of these reliable and inexpensive devices.

Another method of holding a fire in check until evacuation can be completed and firefighting forces can be brought to bear is to provide a sprinkler system which will activate early in the fire and discharge water onto the burning material. These systems, when properly designed and maintained, are able to control the burning rate of the fuel and to inhibit the production of deadly fire gases. These systems have achieved a long and enviable record in protecting commercial property and have recently began to be widely used to protect residential occupancies.

A third method of limiting fire spread, providing time to evacuate a structure, and allowing firefighting forces to arrive and set up to combat a fire is to compartmentalize the structure so that the amount of fuel available to burn is limited by fire resistive building features such as door and walls. The requirements for such compartmentation are called out in building codes.

The United States Fire Administration believes that there is merit in each of these approaches. Used in concert, the elements of detection, fire sprinkler systems and compartmentation can significantly enhance the safety of building occupants from fire and can achieve a significant lowering of the rate of property loss due to fire. We further believe that an integrated system of fire protection can best be designed and implemented by officials working at the local level. Local officials are in the best position to judge the demands of their constituents, the local political and economic forces, and the overall outcome of pursuing mixes of fire protection strategies.

We feel that the United States Fire Administration can most effectively serve this local process by performing research which leads to the improvement in performance of components of an integrated system of fire protection, in making the results of this research widely available to producers of equipment and supplies for fire protection, and in seeking to insure that consensus codes best reflect the latest state of knowledge concerning methods of achieving fire safety.

This concludes my statement and I thank you for the opportunity to testify today. I will be happy to answer any questions.

Mr. **Walgren**. Thank you, Mr. Bragdon. We appreciate those introductory thoughts, and let's go then to Dr. Snell.

Dr. **Snell**. Good morning, Mr. Chairman and Mr. Boehlert. My name is Jack Snell. I'm director of the Center for Fire Research at the National Bureau of Standards.

I, too, would like to take you up on your kind offer to submit my formal comments and speak briefly and directly to four points that I think are relevant to the discussions that we're having this morning.

First of all, in elaboration of the point just made by Mr. Bragdon, yes, there is a continuing problem of fire safety in multi-family dwellings, and it has two distinct aspects. The first of these has to do with the loss of life which occurs primarily within dwellings, and in that sense multi-family dwelling fire deaths are quite similar to those and result from causes quite similar to those in one- and two-family houses. Secondly—the second aspect has to do with fires that move between dwellings, that breach corridors, exit-ways, or fire-safe—fire barriers.

Now from the statistics, it's very difficult to separate out the second category quantitatively, but we know that it's a real problem. For example, recently there was a serious fire in New York City in which seven persons lost their lives as a result of breach of fire protection in barriers that were not properly constructed or maintained. That was the Schomberg Plaza fire in Harlem.

More recently and closer to home, literally in our own backyard, a couple of weeks ago we had a fire in the Londonderry Apartments in Gaithersburg. In this case, there was no loss of life, but in that fire which caused about $2 million damage, 33 to 36 families were displaced, losing their possessions, as a result of a fire that breached fire separations in three buildings. So yes, there is a continuing problem of fire safety in multi-family dwellings.

My second point is—and this supports points made already by both the chair and Mr. Boehlert and Mr. Bragdon—that fire safety in multi-family housing depends on several factors. First of all, it depends on all stages of the building life cycle process—design, construction, and preoccupancy inspection—it depends on patterns of occupancy, and use and activities of the local fire service, and assuring after renovation and modification that fire safety practices are maintained; and, secondly, it depends on a prudent combination of fire safety strategies. These include—and I'll expand a little bit on the list of three presented by Mr. Boehlert—prevention, confinement, fuel control, smoke control, early warning, suppression, and escape and rescue.

Now we can arrange these in different combinations, but the point is, as Mr. Bragdon has pointed out and research and history have demonstrated ever so clearly, no dependence on any one of these—single dependence on any one of these strategies is sufficient.

The issue then is, how do we identify, how do we quantify, what combination of these strategies or how much of any one of these is most appropriate and most cost-effective in a particular application. And that leads to my third point, and that has to do with the value, indeed, the ultimate importance of quantitative tools for fire safety evaluation for permitting us to move from subjective discussion of alternatives to quantitative and objective evaluation of their performance. In fact, we feel that quantitative tools for fire safety evaluation offer three important benefits: first of all, as I suggested, to identify optimal combinations of fire protection strategies. It's not a matter of sprinklers or separations, not masonry or gypsum, but how much of which and what designs of each make most sense in a particular case.

The second advantage of quantitative tools for fire safety evaluation is to enhance the effectiveness of fire prevention measures. I'm talking here specifically about inspection. In talking to a number of local fire officials, I frequently come up with the—come back with the request that we provide the local fire service official with something to—a hook to hang his hat on.

What does he mean by that? He means, very simply, that he needs quantitative, defensible means that he can use to defend his gut, intuitive feelings about whether or not a particular building is safe or unsafe, quantitative tools that can be used to communicate to and motivate the building owner to act in the community's interest.

You know, I recently had the opportunity to read Tom Peters' recent book "Thriving on Chaos." Just by its title, I think it's useful reading for many of us, including those of us in government, in learning how to cope with the environment in which we work. But in there, there were some very interesting examples, for example, that relate to this point about quantitative tools and their application in achieving fire prevention.

It was pointed out that the Frito-Lay Corporation is now installing computers in all of their delivery trucks, the reason being simply to improve responsiveness to customers' needs for their products, to get them there quickly and efficiently.

The other day, in going to a meeting in a downtown Washington office building, in the elevator there was a young lady from Federal Express, and she had a big stack of envelopes in her hand, and as we were riding up the elevator she was using a hand-held bar code reader, and computerized bar code reader, to inventory her packages as she went up the elevator. And yet when we send a fire inspector out to the field today, typically he goes out with a dog-eared code book, a pencil, and a clipboard.

Now it's clear to me that there is much more that we need to do and can do with the capabilities that we have in technology today to support our fire services in communicating the level of fire safety that exists in existing as well as new buildings.

And the third essential aspect of quantitative tools for fire safety evaluation is our ability in facilitating innovation.

Gypsum is not the same as masonry, and new composite materials are not the same—are not going to be the same as gypsum or masonry. Therefore, it makes little sense in our codes or standards to make one product perform exactly the way another product performs. The issue is, what is its contribution to fire safety? and, again, quantitative tools of the sort that we're talking about can do that.

As you know, that's the central focus of our business. We've been keeping you informed on the progress of our development through basic research and application of Hazard, Fire-form, and other tools for making such assessments, and we're making very fine progress.

We have had research associates with the Gypsum Association over the years and currently have a research associate with the Portland Cement Association and the Construction Testing Laboratory working with us to see the extent to which we can adapt these predictive tools to address the quantitative evaluations of precisely the sort that are central to the issue of the performance of fire protection measures in multi-family housing.

In summary, yes, we do have a problem. Quantitative tools are the key. We have technical capabilities at hand and evolving which can help us resolve this problem, and we look forward to working with all of those in this room towards improving life safety, property safety, and reduction of disruption of housing in multi-family housing.

Thank you, sir.

[The prepared statement of Dr. Snell follows:]

U.S. DEPARTMENT OF COMMERCE
GAITHERSBURG, MD 20899

STATEMENT OF

JACK E. SNELL, DIRECTOR
CENTER FOR FIRE RESEARCH
NATIONAL ENGINEERING LABORATORY
NATIONAL BUREAU OF STANDARDS

BEFORE THE

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITEE ON SCIENCE, RESEARCH AND TECHNOLOGY
ON FIRE SAFETY IN MULTIFAMILY HOUSING

JULY 28, 1988

INTRODUCTION

Mr. Chairman, my name is Jack Snell. I am the Director of the Center for Fire Research of the National Bureau of Standards. I appreciate the opportunity to appear before this Committee today to discuss fire safety in multifamily housing. The causes of fires and fire losses in multifamily housing are to a large extent the same as those in single family dwellings. As a significant component of the residential fire problem, multifamily housing fires represent a serious though not unique problem. The one unique aspect of fire safety in multifamily housing is that losses can occur beyond the dwelling of fire origin. New technologies in fire protection are creating alternatives for providing such protection. Quantitative tools for fire safety evaluation are needed to evaluate the inescapable trade-offs between building function, cost and fire safety performance associated with these technologies.

The activities of the Center for Fire Research are directed principally to reducing the residential fire problem and providing quantitative tools for fire safety evaluation.

By way of overview, I will first comment on the fire problem in multifamily housing, the importance of quantitative tools for measurement of fire safety in such occupancies, the role of the Center for Fire Research in providing such tools and conclude with a brief summary of the status of our programs.

Fire Problem in Multifamily Housing

Residential fires account for most fire deaths and a significant fraction of serious fire loss in the United States. As you know, the vast majority of fire deaths in the United States, almost 85%, occur in homes. The problem of fire in multifamily housing, which I take to mean single structures or building complexes which include a number of individual dwellings, can be viewed from two perspectives. First, there are fires within a dwelling that threaten the occupants of that dwelling; and secondly, there are fires in one dwelling that spread beyond or threaten the occupants of other dwellings. The dominant life safety problem in multifamily residences is the same as the dominant life safety problem in single family residences. That is, fires confined to within one dwelling unit. The dominant causes of such fires include heating, cooking, incendiary or suspicious, smoking, and electrical distribution. The major thrust of the Center for Fire Research has been directed at measuring this problem, evaluating the risks and developing means of attacking it. Out of this have come not only the developing risk and hazard measurement tools but also major initiatives on cigarette ignition propensity, furniture ignition and burning characteristics, toxicity, smoke detectors, and residential sprinklers. Much has been accomplished. Yet, much remains to be done in terms of research and translating this knowledge into public acceptance, installation and use.

The second aspect of multifamily housing fires, that is fires in one dwelling that spread beyond or threaten the occupants of other dwellings, is unique to multifamily residences. Historically, fire codes have evolved to minimize the likelihood of such events. It appears that the basic concepts of separation have usually been successful.

However, problems remain. In the 1970's, NBS conducted field studies of fires occurring in these types of buildings in Montgomery County, Md. and nearby locations [1]. Particular attention was given in this study to fire that extended beyond the living unit of fire initiation. These studies found the propagation paths that carried fire from one living unit to another or from one cluster to another resulted from designs that left available paths for fire travel, workmanship errors that failed to complete the intended fire separation, and misuse after the building was completed involving the penetration of fire separations. Individual failures need to be examined, publicized and the lessons learned incorporated into our designs and regulatory practices. Statistically however, this problem seems to be of low significance indicating that performance in this area has been relatively good.

Nonetheless, fires of this sort do occur and often when they do, they create a great deal of notoriety either because they involve multiple fatalities, large dollar losses, a great deal of human suffering, or spectacular fires. For example, the Schomberg Plaza fire in March 1987, in New York City [2], which originated in a trash chute in a 35-story high rise apartment building in Harlem, caused the deaths of 7 building residents and revealed a serious set of deficiencies in construction practice, and code enforcement. Just recently, another, fortunately, less tragic example occurred literally in our own back yard. On July 18 of this year, a three alarm fire in Gaithersburg displaced 36 families and caused about $2 million damage in the Londonderry Apartments [3]. Three buildings connected by fire separations were involved in this fire. One second floor apartment and three third floor apartments of the middle building were destroyed by the fire. Flames estimated at 50-100 feet high spread through the attic of this three-story structure breaching the masonry fire separations from the top according to local officials. Both of these examples involved failures of fire separations.

Almost universally, fire deaths involving such buildings result when the space first breached into is the stairwell or other exit way and victims have become entrapped. Otherwise, as was the case in the Gaithersburg fire, there is ample time for occupant escape and/or rescue, particularly in low-rise garden type apartments or townhouses where construction provides a sufficient time delay to allow occupants to escape.

Because of the extraordinary magnitude of the fire problem of deaths within dwellings in this country, the problem of fire spread between dwellings has received proportionately less attention.

In a broader sense, fire safety in multifamily housing depends on a complex of factors involving all stages of the building life cycle process, i.e., design, construction, inspection and use or abuse, maintenance, renovation/inspection, and so forth. In these structures as in others, a prudent prescription for fire safety involves some combination of the elemental fire safety strategies of prevention, confinement, fuel control, smoke control, early warning, suppression, and escape and rescue. Reliance on any single fire protection strategy leaves the door wide open for disaster. All safety strategies have failure modes with associated probabilities. The trick is to combine sets of strategies into safety systems which are assured to deliver desired performance even when individual strategies fail. Historically, fire safety requirements have evolved as a result of public reaction to specific fires and in a process in which assessments of combinations of these strategies have been made subjectively. We are now entering into an era in which such evaluations can be made objectively on a quantitative basis.

Importance of Quantitative Measurement of Fire Safety

Quantitative measures or tools for fire safety evaluation are crucial for several reasons. The first, and perhaps the most important, is to identify optimal combinations of fire safety measures. By optimal, I mean that set of fire safety measures which provide the most cost-effective fire protection with minimal impact on other building functions, such as, comfort and convenience, affordability, security, etc. For example, it is logical to expect that if residential sprinkler systems are used dependence on structural and other fire safety measures may be reduced, but how much or to what extent? Some argue that increased fire safety must necessarily mean increased costs of fire protection. I do not agree. Although, ultimately, these are political questions, quantitative tools of fire safety evaluation can help focus the debate on the most relevant features of appropriate combinations of technologies and their potential impacts.

The second value of quantitative measures of fire safety performance in multifamily housing is to enhance the effectiveness of fire prevention, particularly inspections. One of the requests we get from fire departments most frequently is for quantitative tools that the fire inspector can use in backing-up--that is, quantifying--his assessments of hazardous conditions. The fire inspector is looking for "a hook to hang his hat on", or means that he can use to convey his intuitive sense of hazard or risk in terms that the building owner will find sufficiently compelling enough to act upon. Obviously, such quantitative tools would also improve the efficiency of the inspection process by reducing the number of repeat visits, the time spent on haggling over interpretations and so forth.

The third benefit of quantitative measures or tools for fire safety evaluation is to facilitate innovation of new fire safety products, materials and systems. Historically, in the absence of tools for performance assessment, new technologies have been required to "look like those with which they competed". The economics of market competition tend to reinforce this tendency. Not infrequently such requirements reach beyond those central to the desired performance. The simple fact is that drywall is different than masonry, and new composite/laminate systems will have performance attributes different than either of their predecessors. Similarly, the existence of sprinkler systems and smoke control systems will alter the dependence upon fire separations, stairwell enclosures or exit way walls from that required in the absence of such systems. What is desired clearly are means to assess the expected performance of various combinations of such technologies.

Central Focus of the Center for Fire Research to Provide Such Measurement Tools

As you recall from our most recent testimony before this Committee, we believe people lack the measures they need to evaluate fire safety. This central focus of the CFR's research is as relevant to multifamily housing as it is to hotel fire safety. As you know, we conduct a program of basic fire research leading to the development of computerized models of fire growth, of smoke movement and of the performance of fire protection systems. In all cases, the emphasis is on measurement and quantification of fire performance, hazard and risk. For example, we have been keeping this Committee informed of the development of the HAZARD I system for fire safety evaluation. Also, we are continuing to develop and refine a set of fire safety evaluation formulas (Fireform) for use by fire protection engineers. We have reported on the use of these tools in investigations such as the Dupont Plaza Hotel fire and more recently the tools have been applied in investigating the First Interstate Bank building fire in Los Angeles. A users test of the prototype HAZARD I system is nearing completion and we expect release of HAZARD I for general use by the end of this calendar year. This tool was designed explicitly for evaluation of within building/dwelling fires. Modification or adaptation of it would be necessary for application to the multi-dwelling fire spread problem. However, planned extensions of the consolidated compartment fire model and HAZARD I will include models of fire growth, improved models of smoke movement and occupant tenability.

We have had a Research Associate program with the Gypsum Association and now have a three year ongoing program with the Portland Cement Association, Construction Technology Laboratories, Inc., to examine the applicability of fire models including Fireform and the HAZARD I system to analysis of the fire performance issues unique to multifamily dwellings.

Simultaneously, we are carrying out work to develop models of suppression, specifically sprinkler system performance. The first fire suppression model will be incorporated in HAZARD II which will be available within the next three to five years. This will enable quantitative evaluation of the sorts of trade-offs being considered today within that time frame.

In parallel with these technical efforts, we are working closely with the potential users of our tools in industry, in building regulation, and the fire services. We are very excited about the enthusiasm being shown by these groups as they try out the prototype versions of these methods and assist us in their refinement.

Ultimately, we envision the day when expert systems for code development, inspection, design, occupant, education and renovation evaluation are used routinely for several of the purposes I have outlined here.

Conclusions and Recommendations

There is a problem of fire safety in multifamily dwellings, one which is much the same as that for residences generally. We believe it is important to be careful how the essential balance between function, cost and fire safety is made to assure on the one hand essential safety is not compromised and on the other that affordable housing can be provided. We believe that the quantitative tools for fire safety evaluation will not only help in making the essential trade-offs but in guiding the development of improved technologies for community fire safety.

Whereas principal attention today will be directed to codes which will address the buildings of the future, attention also needs to be directed to hazards in the existing housing stock. There are several steps that can be taken now to clarify the issues and work the problem of fire safety in existing multifamily housing. Fire departments that routinely visit individual dwellings report such efforts have significant impacts on fire loss. Such assessments provide opportunities to directly educate occupants concerning fire safety, provide on the spot guidance concerning correction of deficiencies, and an inventory of problems requiring further attention. We stand prepared to work with the fire services in development of inspection tools and guidelines which would effectively empower the local fire services to vastly enhance the cost effectiveness of such inspection/inventory programs.

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BIOGRAPHICAL SKETCH

Jack E. Snell, Director
Center for Fire Research
National Bureau of Standards

Dr. Snell was appointed Director of the Center for Fire Research of the National Bureau of Standards (NBS) in 1981. Established in 1974, by the Federal Fire Prevention and Control Act, the Center conducts basic and applied research into all aspects of fire. The Center has an in-house staff of over 90 including 60 engineers and scientists, and as many as 20 guest workers and visiting scientists. Grantees at 28 leading universities complement the in-house effort. A central focus of the Center's work is development of practical, scientifically-based tools for advancing the state of the art of fire protection engineering.

Dr. Snell joined the National Bureau of Standards in 1971 following military service in the U.S. Air Force, a position in airline maintenance engineering, and research and teaching posts at Princeton University. At NBS, Dr. Snell headed research efforts relating to building service systems and the NBS programs in energy and energy conservation.

Dr. Snell is Co-Chairman of the U.S. National Fire Research Strategy Conference; Member, National Fire Protection Association; Chairman, NFPA Advisory Committee on the Toxicity of the Products of Combustion; Member, Society of Fire Protection Engineers; and is a member of the ASTM Committee E 5 on Fire Test Standards. Dr. Snell has a BSE from Princeton University and MSE and PhD from Northwestern University, and is a recipient of the Department of Commerce Silver and Gold Medals.

Mr. **Walgren**. Thank you, Dr. Snell. We appreciate that statement.

Mr. Holman.

Mr. **Holman**. Thank you, Mr. Chairman, Mr. Boehlert.

Secretary Pierce regrets that he won't be able to appear before you today regarding fire safety in multi-family housing. He has, however, asked me to provide the information requested in your letter of invitation on July 18, 1988, since the office I direct is responsible for the fire safety in HUD-assisted new multi-family housing and specifically HUDs minimum property standards, the MPS. HUD's MPS were established soon after the creation of the Federal Housing Agency in 1934 and were reissued in 1984 and revised in 1986.

Fires in the early 1970's prompted improvements in the fire safety features of HUD's minimum property standards for new buildings such as smoke detectors, sprinkler systems, and compartmentation. HUD's means of improving the MPS, however, didn't always match simultaneously improvements made during the decade of the seventies in the other nationally recognized model code methods for accomplishing the same goals. Multi-family housing that has been built since then using either improvements in the MPS or model codes, however, has had an excellent fire safety record.

The Department has reviewed the improved fire safety requirements in the model codes and found them to provide protection that is comparable to that previously provided by the MPS for multi-family housing. Our experience since 1934 has been that the fire safety has been well regulated by model codes as soon as research and technology provide them with sufficient information to act. The Department concluded, therefore, that it would be appropriate to rely on the fire safety requirements of the nationally recognized and widely used model building codes rather than to continue to impose a confusing and duplicate set of standards.

Let me emphasize, however, that HUD has not withdrawn the MPS for multi-family housing. We have only substituted by reference similar model code requirements. HUD recognition of model codes has led to their wide use and decreased local efforts to lower fire ratings for walls, et cetera. The Department, like the President's Commission on Fire Safety, believes that fire safety is best controlled by local government and the model building codes that they jointly develop.

HUD is an active player in assisting model code organizations by leveraging and effecting changes also needed by the increasing majority of States and local governments using nationally recognized model building codes. For example, the Department has supported recently adopted model code requirements missing from prior MPS that will require sprinklers in most multi-family housing units from now on.

In determining the comparability of State and local codes, the Department relies in part on the recommendations of the congressionally chartered National Institute of Building Sciences—NIBS—the President's Commission on Housing, OMB Circular A-119, and Section 526 of the National Housing Act as amended in 1983. The

Department's method for determining when State and local codes are comparable has met with widespread acceptance.

One misconception, however, appears to be that the former MPS did not allow tradeoffs were sprinklers were installed. To the contrary, the MPS, like all nationally recognized model codes, have always allowed tradeoffs in return for installation of sprinklers or other safety devices.

Fire statistics do not indicate which, if any, of the 1986 fires in existing multi-family housing were in buildings assisted by HUD. Nor do the fire statistics identify the building codes and standards which were used to construct or possibly alter the multi-family housing that has been damaged by fire. We believe that most fire fatalities now result from smoking, furnishings, and code violations rather than inadequate construction standards.

There are, of course, other hazards in addition to fire that impact on fire safety standards. Gypsum frame dry-wall rather than masonry fire walls are preferred in earthquake-prone regions for their superior low cost ability to resist earthquake damage. In fact, HUD pioneered the gypsum fire wall. It has performed well and is a fire standard in all the nationally recognized model codes except the National Building Code which serves a region with little recent earthquake activity.

I have prepared responses to the specific questions posed by the committee and will be happy to answer your questions at this time or supply additional information for the record.

Thank you.

Mr. WALGREN. Thank you very much for those statements.

I come to this area relatively new. I haven't had any involvement in fire on a local level. Some Members in the House have and bring a tremendous amount of practical experience to it. I have only been struck by the fact of reading the original America Burning report when there was no Federal involvement in fire at all, and a bipartisan commission, as you know, who are involved in it reported in 1974 that there ought to be a major Federal involvement in fire in order to reduce the loss of both life and property, and they set out a road map for that involvement that involved a substantial effort, certainly considering that we were making no effort prior to that time on the Federal level, at least in any coordinated way. They set out a substantial effort through the United States Fire Administration and the research branch at the Bureau and the Fire Academy and called for the expenditures in 1976 and '78 time frame of something in the range of $130-plus million a year.

As Government, we have never pursued that, at least not on that level. We have topped out not at $130-some million a year, even considering 1977 dollars, but we are presently in that effort investing about $17 million or thereabouts instead of $134 million, and that has to really tell you something, it seems to me, because to me it's a measure of the distance that we have kept between Government and the fire problem, and I wonder whether we are keeping the same distance in the pursuit of these tradeoffs.

We all know that sprinklers are a very powerful system, and yet it is obviously true that unless they work almost all the time, we're setting up a situation where there would be very little protection to fire, in fact, maybe allowing a situation which might encourage the spread of fire, if we trade off.

Can you talk a little bit about this concept of tradeoffs? Mr. Bragdon, you talked about alternatives, but alternatives clearly imply the delivery of the same degree of protection or the same kind of protection and also a very confident evaluation or assessment that the system will perform in all cases, and I don't know from our statistics and the like that we have much firm basis for making that kind of conclusion.

So I guess the fundamental question I have is, given the importance of redundancy in fire safety or in any safety question, can sprinklers be traded off against other built-in fire safety factors?

Mr. BRAGDON. Again, I prefer the word "alternative," because I believe the end goal is to afford in risk management an appropriate level of life safety and fire prevention, and what I'm trying to describe is that there is more than one alternative to reaching that goal.

It might serve well, by example, to do something out of my former life where, in Los Angeles County, to this date they do not have a requirement for residential sprinklers and as of about five years ago had over 1,000 residential sprinkler systems installed as a consequence of alternatives. Not in the structural part of a building or residence or multi-family but in other areas, we had a fairly strict fire flow requirement for water supply. We had an access requirement for emergency vehicles to buildings, whether they be apartment, single-family, or not. We would allow an alternative of the installation of a sprinkler system to reduce, not eliminate, but to reduce some of those other requirements that had nothing to do with the structural integrity of the building. In our judgment, the building was afforded an increased level of fire protection from this alternative because it no longer had to rely entirely on public response resources.

Other jurisdictions are doing it on the basis of proximity to public protection, where the jurisdiction or the entity as a whole then does not have to continue and to invest in public protection which has to be maintained over a long period of time, and I'm talking about fire houses, I'm talking about fire fighters, and fire engines, and so forth. That problem grows when the technology is available to start over the long term addressing that, because the public jurisdictions no longer have the financial capability to continue ad nauseum to add public protection resources when there are alternatives to that.

We see that kind of application certainly, and I could make some maybe oblique reference to an incident in Los Angeles recently, the Interstate Bank fire. There are several situations served by that particular incident that are beneficial to be heard on a national basis, and there are reports that will be coming out on that from the National Fire Protection Association, from the City of Los Angeles itself, and others.

The ultimate cost of that fire will be in the hundreds of millions of dollars when we take the direct and indirect cost: a building of $60 million construction value in 1973, approximately $200 million to this day; but the loss of business, the employ, the loss of rental space; several things.

But what occurred there? That building was, in fact, built in accordance with the state-of-the-art codes in 1973, which did not include sprinkler systems. Even though the technology was available, the system—the system and the political structure and so forth did not place those, I think vital, property-saving and life-saving devices in place. A very responsible management, however, was in the process of installing and had it 90 percent completed when that unfortunate fire occurred. Certainly a lot of lessons and certainly a lot of reaction to that.

I don't know what the status is in the city of Los Angeles, but I know the State of California now is talking about amending their high-rise ordinance—and high-rises also are in the multiple residential business—to include retrofit where, since 1974, sprinklers haven't been a requirement.

In that requirement—

Mr. WALGREN. But it's your experience—if I might—that the tradeoffs for sprinklers are not in California related to any structural change in the codes.

Mr. BRAGDON. I would suspect that in some jurisdictions that's not true. There are some structural provisions in the codes that are being traded off.

In the instant case I mentioned of the Interstate, there was no advocacy to trade off any of the other systems with the introduction of sprinklers, but many of those other systems failed during that fire, because you had a 62-storey building with all the storeys above the twelfth floor filled with smoke.

Smoke removal, the integrity of the interior stairways and other conduits obviously did not work. So that's why we'd like to, again, give emphasis to a systematic approach. Something did not work. That was the state of the art 15 years ago. You can transfer that application, and I think when we get into the one- and two-family dwellings we've traded off everything that was there anyway. There's nothing much more to give away in that particular environment relative to life safety, so now we're talking in terms of multi-family where you have more people at risk and exposure.

I wasn't trying to avoid your question. I think—and do not like the word "tradeoff," even though it's being used extensively. That decision—

Mr. WALGREN. The question for me is, sort of, why do we use that word "tradeoff," and some instinct in me says that we are so reluctant to develop the governmental requirement, or the requirement by government, that we have to look for all kinds of ways to make things happen without requiring it to happen, and clearly we want sprinklers to be broadly encouraged and brought in in any way we can, because, as I understand it, most people who look at the effect of a sprinkler and its ability to stop a fire before it starts—we are captivated by that, and it is a good solution that clearly saves tremendous loss, and yet we won't require it just because we apparently don't like to require things.

We're having a terrible time requiring sprinklers in hotels that are so wrapped up in interstate commerce it hurts, and yet we were not able to get agreement in the Congress anyway on a penalty that would effectively require it. So instead of requirement, we seem to be tempting people to install the sprinkler by trading off.

Is that where the "tradeoff" word comes from, that we can't get them to do it without trading something for it?

Mr. **Bragdon**. The problem and its resolution all evolves around a single thing, and that's money. I think that money enhances the use of the word "tradeoff," because when you start dealing with an industry that can, in fact—and I'm talking housing industry—influence, we have yet, and we have failed to convince the American public and our political leadership that life safety is a commodity that does not need trading off, that we can add to life safety, but what we do when we have our successes, or alleged successes in that particular arena is to say that, "If you give me that, you can take that back, and the net effect is, it doesn't cost you any more."

So I think that's how we've evolved into the utilization of the term "tradeoff." The end result, it does not cost you more, in fact, may even be cheaper as you go into these alternatives or tradeoffs, as I would describe in that particular sense. So because we have failed to convince the public and our leadership that life safety is a marketable commodity.

Mr. **Walgren**. Dr. Snell, would you like to—can you make any comments on this concept of tradeoff? And it really implies being able to assess or take clear measure of what it is we're giving up when we give up a requirement for a structural factor, and how good is our research data to give us confidence in being able to tell what it is we're giving up when we lessen a requirement for a fire wall or the like?

Dr. **Snell**. That's a very difficult question, Mr. Chairman. I agree that there is an ominous aspect to the use of the word "tradeoff" in this situation, and I think it's enhanced by the absence of the ability to characterize or quantify or measure the level of safety that the Government, you, politically, or communities set and desire for homes and for various other occupancies.

The issue is clearly one of establishing a scale and finding a place on that scale that the community or the politic is comfortable with, and clearly in this instance the level of achieved performance is too low, because the losses are too high. We got that part right, but what we don't have is a sufficiently well defined yardstick to answer sharply the detailed question that you just asked, and that is, do you get less life safety, do you get less property damage, by a combination of sprinklers and less investment in physical separation than you do with some other combination of those various measures?

Now we can evaluate the performance of specific combinations in tests, in large-scale tests, and we're improving our ability to simulate the performance of these technologies analytically. Do we have that capability? Absolutely. Are we using it routinely? No.

Mr. **Walgren**. I mean, clearly, if you add sprinklers you're going to be able to say that, well, this is generally more safe, and that's probably objectively true. But isn't it more safe in a different way? Are we really comfortable giving up the kinds of structural fire safety systems that have been required in terms, or at present, in building codes because we're adding the probability of sprinklers being so nicely effective?

I guess my question is, shouldn't they be considered separately in terms of this concept of reducing code requirements for structural safety?

Dr. SNELL. Are you saying shouldn't—

Mr. WALGREN. Sprinklers.

Dr. SNELL. —sprinklers and suppression be considered separately?

Mr. WALGREN. Yes.

Dr. SNELL. I mean sprinklers and separations.

Certainly you want both. I'm very uncomfortable with the idea of giving anything up in terms of fire safety. One thing we can give up is the cost. I mean if you look at the total investment in fire safety, we're not doing as much as we could, but we're not optimizing the resources that we're putting to it anyway and for the same reasons of difficulties.

There's no question whatsoever that fast-acting sprinkler systems in residential occupancies are and will have a very tremendous impact in reducing loss of life, in reducing extent of displacement, and reducing extent of property damage. We know that. But when you go to the fine edge and say, "Okay, does that mean that we can back off on those savings somewhat by reducing some other aspect of fire protection in the absence of any objective measure of it?" and in that area I get very uncomfortable, and I think you should be too, and I think that's what makes Clyde uncomfortable with the term "tradeoff," not because tradeoff may not be in some instances necessary, but when we're required to do it in the dark we all get very uncomfortable. That makes simple sense.

Mr. WALGREN. Let me ask Mr. Holman: Your testimony indicates that since 1934 fire safety has been well regulated by model codes, and you felt them sufficient, given when research and technology became available and they had sufficient information to act. You're using national codes, as I understand it. Is that right?

Mr. HOLMAN. Yes, sir.

Mr. WALGREN. And housing constructed with Federal money must meet the national code. Is that correct?

Mr. HOLMAN. Close. Before 1974—excuse me, '84—we had the minimum property standards which gave specific fire safety criteria. What happened through the 50 years of the Federal Housing Administration or similar predecessors to that was, we were first. There weren't any national model codes, and the housing agencies of this country decided that there needed to be some kind of a fire safety criteria established, so we wrote them, we being, obviously, my predecessors; I'm not quite that old.

As time went on, the cities and the States added to their repertoire of fire safety criteria, and as time went on the model code organizations developed. Through the sixties and seventies, the fire criteria got better and better, and HUD-FHA made some very major improvements, as did the model code organizations.

The problem was, we didn't necessarily do it simultaneously or exactly alike, so when a builder-developer would go out and want to build a HUD building under one of our programs, he had to comply with our criteria and, in addition, the local criteria and, in addition, maybe some insurance criteria. So it got very, very confusing.

As a result of various issuances in the early eighties under the President's Commission on Housing and, quite frankly, OMB A-119 which directed the Department to use, where practical, voluntary codes and standards that are developed in the private sector, and if there weren't those in the private sector then the Department, as the other agencies, were directed to participate in the development of private codes and standards, and that's what we're doing today.

So it's basically an evolvement through history. We're at a time now that we decided that the private sector has basically caught up, and in 1984 they were so similar that we didn't feel that it was necessary to impose two different standards on the developers.

Mr. **Walgren**. But now let me ask you this. You indicate in your testimony that the fire statistics don't indicate which, at least in 1986, of the multi-family housing were assisted by HUD, nor do they identify the codes and standards used to construct, and yet you believe that most fire fatalities now result from smoking and the like, and that's, I'm sure, a reasonable belief. But is it true that we really don't have statistics that go to the level of evaluating this change that was made in 1984 with respect to the adequacy of relying on the local codes?

Mr. **Holman**. The change was made by comparing the minimum property standards to the current model codes, and because they were so much alike we didn't see that it was necessary to continue with something similar but just slightly different. That was why the decision was made.

Mr. **Walgren**. Were there any estimates of reduced costs of construction when you made that change?

Mr. **Holman**. I don't believe that there were. It was just a direct comparison from the model codes to what the MPS contained.

Mr. **Walgren**. Okay. Thank you very much, and I appreciate my colleagues' indulgence.

The chair recognizes the gentleman from New York, Mr. Boehlert.

Mr. **Boehlert**. Thank you, Mr. Chairman.

At the outset, I should plead guilty to looking for simple solutions to complex problems. But the more I get involved in fire safety the more frustrated I get. I mean my opening statement said it. We have the highest death rate and the highest property loss rate in the industrialized world due to fires, and yet we've got all this sophisticated technology and we can't match the technology with the problem. Can you give me some encouragement? What can we do? I mean it's so frustrating. We try a very simple thing like encouraging—I'd like to force the hotels and motels of America to install sprinkler systems, and we're running into all sorts of roadblocks all over the place, and all I want to do is save lives and protect property. Is there something you can suggest for me? Wave a magic wand. Give me some guidance.

Mr. **Bragdon**. If I may, Mr. Chairman and Mr. Boehlert, obviously, when you have an altruistic mission it should be simplistic, because I think it's a worthy mission, and why is it complex? Maybe it's complex because we allow it to be such.

I would like, before we leave that subject the chairman raised—I think the model code organizations have made great and significant progress in recent years, and now, through their apparent oversight organization, CABO (Council of American Building Officials), is trying to do more to come up with a national standard, literally, so you will not have maybe three major model code organizations with some significant differences.

We're seeing a coming together, and that ultimately will serve, obviously, the citizenry well, because as we become smaller as a result of communication and transportation, those who are responsible for our built-in environment have some uniformity in what they do, and they are well supported, and I think in an appropriately administered standards organization.

But that is a slow, sluggish process, and so forth, and obviously we get very impatient that there is a lag factor there, I think, that technology is not introduced, and sometimes it's the outside influences and forces, such as may be represented in this room today, that make the progress occasionally move a little faster.

But the bottom lines of all of that, those are only models, and ultimately, whether it be at the State or local level, it's the authority having jurisdiction that adopts those and puts those codes and standards into use, and you'll still find vast areas of this country that have no codes or standards.

I would even be interested in knowing—and I think we received the answer—how HUD addresses that when they have public housing funds in areas that have no codes. Then, obviously, they have to revert back to some other standard, because there are jurisdictions that are not paying a lot of attention to what's available to them, and therefore they create not only problems now but certainly built-in problems to the future.

Mr. BOEHLERT. Mr. Holman, what happens when you're going to have it Federally subsidized?

Mr. HOLMAN. Yes, that's precisely right. Basically, what we do is, we review the local code for a comparability to a model code, and if there is no local code then we move to the State code. If there is no State code, then we go to one of the major model building codes.

Mr. BOEHLERT. Then you go to the—what's the last one?

Mr. HOLMAN. We go to one of the major model building codes, one of the three major model building codes.

Mr. BOEHLERT. Which one do you select, and how do you make that determination?

Mr. HOLMAN. It's not our selection, it's the developer's selection, and generally, depending on where they are, they go with the one that they're used to.

Mr. BOEHLERT. Are there great variations in the model codes?

Mr. HOLMAN. Not particularly, no, sir.

Mr. BOEHLERT. Is there a need for three separate model codes?

Mr. HOLMAN. It depends on who you talk with.

Mr. BOEHLERT. Well, I'm talking with you.

Mr. HOLMAN. Well, actually, the criteria are pretty much the same. There is a lot of reasons why there's not just one code. One of the reasons is, you have three private sector industries that produce each of the codes. That's one reason. The second reason, and perhaps more importantly, is that if a particular industry association loses in one of the model code organizations, they can win in the other two, or vice versa, so you don't cut out one sector of the industry just because you have one chance to do it in one model code.

Mr. **Boehlert**. The question is—and a good question—does the Federal Government actually go back in and inspect—see that the codes are adhered to?

Mr. **Holman**. Not exactly. We have a process called direct endorsement, and basically it's handled by a certification process. We review the developer to see whether he has the capability and ability and maybe moral commitment, if you will, to do it correctly. We make that up front determination, and if he does it correctly then we from thence forth accept his certification.

Mr. **Boehlert**. You know, we're guilty, I think, in this town—we're kind of hypocritical, particularly those of us in Congress, present company excepted, but we're great at telling everybody to do everything, but we sort of don't do it ourselves. What is being used to determine fire standards in Federal buildings, for example?

Mr. **Bragdon**. These people may have more knowledge than I do, but I think you have several systems in place, and, as you just mentioned, the Congress itself excludes themselves from many things and has control of their own destiny because their buildings are controlled by the Architect of the Capitol.

Many Departments, depending on who owns the real estate or how it was provided to them, have that direct responsibility, and of course the largest landlord of all would be your military branches to the Department of Defense who make their determination separately. Then, of course, next to that would be the General Services Administration which has responsibility for a lot of the buildings that are leased, rented, and the standards applied therein. So you have a multiple—

Mr. **Boehlert**. DOD, it's been my experience—I have a major Air Force installation in my district—that they are very fire safety conscious. Is that your experience too, or have I been misled?

Mr. **Bragdon**. It would be my sense, yes. Also, I think there's areas, too, in that respect, that there's some state-of-the-art technology that there's a lag factor at the defense establishment, and we have been working with certain branches on doing—for example, I think we've had testimony to the fact in the past year of retrofitting into the military housing area.

Obviously, there's a tremendous resource investment, if you want to put it that way, that the Government has in those personnel and their families, and they deserve that level of protection, again, I think, going along the theme that the Federal Government should be exemplary in its own practices that they have an advocacy that the private sector should be.

Mr. **Boehlert**. Yes. We should be setting the example, and we don't, unfortunately, in so many areas, and so that's why, for the unit itself, I'll plead guilty to hypocrisy.

We're going to hear arguments that the current fire rating tests are outdated and inadequate. Do you agree to that?

Mr. **Bragdon**. I would defer. I have certainly read that. I have no technical competence to specifically respond to that, and, if I could, I'd refer to Dr. Snell.

Mr. **Boehlert**. Jack.

Dr. **Snell**. Yes, I think it's accurate to say they're outdated. The history of their development is rather well documented in that testimony, and there's a lot more that can and should be done to bring the requirements for construction assemblies, and partitions, and so forth, into some defined relationship to the fire loads that are likely to arise in new dwellings, and those fire loads have not been constant over time, as has accurately been pointed out, and efforts to continue the development and improvement of those tests have not been undertaken.

Mr. **Boehlert**. We've had a proposal for a balanced design concept in code making whereby a variety of fire safety features are adopted. How feasible is it that State and local jurisdictions will accept the concept of balanced design as opposed to the concept of tradeoffs—that naughty word?

Dr. **Snell**. Well, I think you want to be very careful about how you define it so that "balance" doesn't become the same kind of a naughty word as "tradeoffs." If you mean a demonstrated performance to well established objectives, then "balance" has a good and positive connotation, but if you mean by "balance" look to this technology to take care of life safety and that technology to take care of property damage I think you're simply adding confusion. The fact of the matter is that most of these technologies affect life safety and property protection and displacement and in fairly complex ways, and we need to be very clear about what those impacts are.

Mr. **Boehlert**. Let me ask you one last question.

Dr. **Snell**. But, to be short, if I may, yes, I believe that we can and, in fact, are delivering to local jurisdictions tools that allow them to make intelligent decisions about combinations of fire safety measures, and our ability to do that is improving every year.

Mr. **Boehlert**. I think Dr. Snell and Mr. Bragdon know, as a result of previous appearances before the two of us, that we'd keep you here all day and all night if we could, because this is an area of vital interest to us, but I'll defer to my colleagues in the interests of time.

But I do have one last thing. Mr. Chairman, I can never resist that. Let me ask you, would a gypsum wall with a one-hour rating differ significantly from a masonry wall with the same rating?

Dr. **Snell**. In terms of the performance in that test, no. They both meet the requirements of that test.

Mr. **Boehlert**. Okay. Thank you.

Thank you, Mr. Chairman.

Mr. **Walgren**. The chair recognizes the gentleman from Pennsylvania, Mr. Kanjorski.

Mr. **Kanjorski**. Thank you very much, Mr. Chairman.

I have the unique honor of sitting on the Housing Committee too, so I guess I'll try and direct myself to a portion of the chairman's statement when he opened up the hearing, and that is that apparently since 1984 we've done away and abolished our multi-family codes at the Federal level. Has there been an appreciable increase in loss of life or property that's discernible as a result of that decision, or has it not been studied?

Mr. **Bragdon**. If I may, sir, I do not believe the information system that we have available will make the distinction as to the funding base for the housing that you're speaking to so that we can say. However, overall, prior to your arrival we did address the fact that there has been literally a one-halving of the loss of life, if that's the factor, in multi-family housing in the last decade.

Mr. **Kanjorski**. What's that attributed to?

Mr. **Bragdon**. A variety of things which we addressed: public education awareness; improved codes and standards; multi-family housing is subject to greater scrutiny as far as inspection and enforcement than you will find in single- and two-family housing; the introduction of the technologies such as the smoke detector; and several other things that we had listed at that time.

Mr. **Kanjorski**. I notice 80 percent of the deaths occur in single homes. Is there any classifying? Do these occur in ghettos or in tenement buildings, or are they in subdivisions in the suburbs, or is there any differential there? Is there some group that we're not reaching or not educating, or is it just happenstance where these losses of lives occur?

Mr. **Bragdon**. No. Our information does clearly tell us, of course, that all housing occupancies are vulnerable. However, there's a higher rate of—and I think reasons that we all can recognize—in rural America—believe it or not, it's probably one of our higher incidences—and certainly the inner city, and you're talking about quality of housing, you're talking about a lot of violations, lack of good enforcement, for a whole variety of reasons, but no housing is immune, obviously.

Mr. **Kanjorski**. Is there any ratio worked out in cost savings of, you know—what would the decrease in the loss of life and the decrease in the loss of property relative to what we would spend or the developer or the owner would spend? Are there any ratios that have been worked out?

Mr. **Bragdon**. We have commissioned, and the National Bureau of Standards, in addition, have done cost-benefit studies on, for example, the installation of sprinkler technology. I think we anticipated the results as if one is willing to quantify and publicly what the value of a single life or several lives would be, and put it in those terms. Then we could say—declare yes, the installation of sprinklers in the single- and two-family dwelling is not cost beneficial on those terms. I will not make or advance that kind of statement and put or assess a value to a life.

You get a different reflection because of the exposure of lives in the multiple-family, and so the equation turns out differently. So I think you have a different approach.

Mr. **Kanjorski**. Well, I guess what I would say, certainly we wouldn't put a value on life, or there probably isn't a way of putting a value on life that would be reasonable in our society, but if we're trying to protect life as opposed to property in the housing area, we just really want to save the life. Sometimes it would be more expensive if you tried to decrease the cost of the property, and it wouldn't be cost beneficial, but the life, it seems to me there are ways of—

Mr. **Bragdon**. I find the two integrally entwined. I don't find the separation or what some people describe as a reemphasis from property protection to life safety. I will grant you that in the past the systems were designed primarily for property protection. I do not think that deteriorates primarily if you try to enhance life safety, because if life safety means extinguishing the fire in its incipient stages, obviously then you're going to minimize property damage as well. I think they're complementary and do go hand in hand. But I think it has to clearly to state our emphasis in the past was property protection.

Mr. **Kanjorski**. Let me ask you this. I'm impressed with the fact that we've had so many major cities in the United States burn down compared to the rest of the world. I was thinking of Chicago the other day and San Francisco. Are the other industrial nations of the world suffering the same type of catastrophe as we have?

Mr. **Bragdon**. I think there are periods within their history that that is true, but one would have to reflect on the construction methods, the materials available in those jurisdictions, and, as we gave great emphasis earlier, the public attitude towards fire and life safety that prevails to a greater extent in other countries than it does here. It's those lessons that we learned as practically every major city in this country had a major fire within its history that we are building, as I gave emphasis to earlier, with appropriate kind of separations. They really were the basis for maybe fire protection, separation, rated walls, distance, and so forth.

Mr. **Kanjorski**. I guess, Mr. Chairman, I only call the chairman's attention—and I don't know whether he had this experience in private life, but as an attorney, almost every county my law firm investigated their records in the United States, we would go back to the point when the county courthouse burned down, and it's interesting that all the county records would be destroyed. It's almost the experience of every county in Pennsylvania I know.

Mr. **Bragdon**. And I might add to that the Federal Records Center in recent years.

Mr. **Kanjorski**. An interesting point. Does that happen in Japan too?

Mr. **Bragdon**. No. Japan has an enviable record when you think of the vulnerability because of the nature and proximity of their construction, but they have a public attitude. They don't praise people, they condemn people, for having fires. They give great emphasis in their public protection agencies primarily to fire prevention, which this committee has addressed time and time again, that we do not do in this country. That's the first thing that falls out when there's a reduction of resources at the local level. We do still have a fire engine mentality.

Mr. **Kanjorski**. Perhaps then you're saying that our attitudes that we feel sorry for people and we don't necessarily place fault, we try and provide support systems after the fact as opposed to setting a high standard for people to adhere to, and maybe that's where our emphasis should be.

Mr. **Bragdon**. That is correct.

Mr. **Kanjorski**. Thank you.

Thank you very much, Mr. Chairman.

Mr. **Walgren**. Thank you, Mr. Kanjorski.

The gentlewoman from Maryland, Mrs. Morella.

Mrs. **Morella**. Thank you.

It's a good point for me to come into the discussion briefly. First of all, I want to commend the chairman for holding this meeting on such an important issue as fire safety in multi-family dwellings and the very prominent panel. And I'm pleased, of course, that the Bureau of Standards is here and that we have such distinguished people.

But the concept of prevention is one that I guess I can cite the jurisdiction that I'm honored to represent, because it was just recently that Montgomery County, Maryland, suburbs of Washington, celebrated the tenth anniversary of the first smoke detector ordinance in the Nation, and they found that in that ten-year period the significant reduction in fire-related tragedies, deaths, that have occurred. It was like 60 percent.

Currently, the jurisdiction is looking into even requiring a sprinkler system in residential dwellings, I mean single residential dwellings, and, again, they may move forward with doing something specifically on it in the way of an ordinance.

So I'm pleased that you're here, and I just have a few questions to pose. One has to do—and maybe this particularly is directed to Dr. Holman, and that is the concept of the Federal Government constantly buying subsistence housing and acquiring buildings for Federal agencies. Now how do you cope with the fire safety measures in those buildings because I guess the code—the codes in general are not retroactive. What do you do about that?

Mr. HOLMAN. Unfortunately, I'm the director of the area that creates the standards for new construction, so I really can't address that question.

Mrs. MORELLA. Is there anyone else who might, who might want to tell what should be done?

Mr. BRAGDON. As the Government involves themselves in subsidized housing, if there's work to be done, the model codes will provide for bringing that structure up to date, depending on the percentage of work that has to be done to rehabilitate the structure. That, in part, is an answer but certainly not the total. If the subsidized housing does not require that work, then there's obviously no involvement or retrofitting, as you might say, to bring it up to current code standards.

Mrs. MORELLA. Let's just say the District of Columbia is an example. Would it take some of the buildings they have there and with Federal assistance they could use it for multi-family housing, which I think is something they should do. What does that mean then about the codes? Would that be considered new construction if it's really renovation?

Mr. BRAGDON. If they are changing the occupancy use, most codes would provide then that change would allow the introduction of a code standard, current code standards. So there's not a direct answer. It depends, I think, on the nature of the building and the status and what level of rehabilitation is required.

Mrs. MORELLA. Okay. Should something then be done about those where it's not restructuring it completely, as you mentioned? Is there a need then that we do something to make these codes retroactive in other instances? Is that a recommendation?

Mr. BRAGDON. I believe there is a decided trend. Retroactivity is something that was never really discussed much in the past. People did conform at the time—making that assumption, they conformed at the time of the construction, and you did not talk about retroactivity unless there was a prevailing public safety or public issue involved, and then, of course, the leadership would allow them that.

We're finding more and more retroactive provisions being built into the law, again, under the prevailing basis that public safety is at stake here. So that's really and should be appropriately a local jurisdiction.

Obviously, if the Federal Government is involved in everything, they should have some leverage if their funds are being utilized in the process.

Mrs. **Morella**. So it may be something that we should suggest be done by local ordinance.

Mr. **Bragdon**. I think I would go stronger than suggesting.

Mrs. **Morella**. Mandate.

Mr. **Bragdon**. That's not—

Mrs. **Morella**. That's a little too strong?

Mr. **Bragdon**. —a politically feasible word, but the other option is not providing the subsidy.

Mrs. **Morella**. That's pretty much like mandating. Very good.

Dr. Snell, could the Center for Fire Research, which does the predictive computer modeling of fire scenarios, could that be used to determine what is an adequate level of fire safety in the construction of multi-family units?

Dr. **Snell**. It can be used as a measure of the level of a particular design, but the answer to what level and—and the consequences of a particular design in terms of likely loss of life, damage, and injury. But the answer to the question in terms of what level is acceptable is a community political decision, and a very important one.

We're committed to developing the measurement tools and to demonstrating, using those tools, what the consequences of various alternatives are likely to be and to make that information available to the body politic for facing up to that kind of question.

Mrs. **Morella**. Do you have any idea of whether the codes are compatible with the research?

Dr. **Snell**. Yes, I think to a large extent the codes tend to lag the research. To some extent, that's as it should be. To others, that's simply a reflection of the time it takes to introduce new technology through that process and the priority that we put on change in this area.

Mrs. **Morella**. If the codes in some instances lag behind in a deleterious manner, what's your role then? Do you just simply advise?

Dr. **Snell**. Let me address the positive side of that first, because there are some very outstanding examples of efforts on the part of model code organizations to move forward and take advantage of the very latest developments in these predictive tools. For example, the ICBO on the West Coast is working jointly with us right now in training their people in the use of these computer methods so that they can use them directly in making better informed decisions about code change proposals.

The other side of that question is that our single weapon is scientific and technical information, and historically we've found when facts are put on the table, typically, things move in the appropriate directions. It's when the activities are inadequate to produce that information that the whole community suffers.

Mrs. MORELLA. Those who are putting together these code criteria concepts, are they required to get the information from you? How does that work? Is it optional?

Dr. SNELL. The code process in this country, as you know, is a voluntary consensus process so that the information, technical, experimential, and otherwise, that goes into the decision-making process comes from all elements of the community. Sometimes it comes from our laboratories; sometimes it comes from private testing laboratories; sometimes it comes from industry's own research; and usually it's the combination of those—information from those sources on which the decisions are based.

But as I said a moment earlier, the biggest problem we have is when the resources are not there to provide the technical information needed to make intelligent decisions, and that's too frequently the case.

Mrs. MORELLA. That's very, very interesting. What can we do about that?

Dr. SNELL. Address the level of effort associated with producing such information.

Mrs. MORELLA. Okay. A very good answer.

I have no other questions. I just want to make a comment since the ranking member has now rejoined us, and that is, I was pleased that he made the statement about governmental buildings where Members of Congress, who so often exempt themselves from legislation, spend much of their time, and I'm pleased to announce that he is cochairing a fire safety task force to make sure that we don't have a recurrence of what happened in the Longworth House Office Building, when we had no alarm system, no sprinkler system, and none of us believed that actually there was any fire that was taking place.

So I want to also compliment you on the meeting you're going to have next week and hope you keep us all informed of that, and thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mrs. Morella.

I wanted also to ask Mr. Holman: You indicated in your testimony here that HUD has been an active player in assisting model code organizations by leveraging changes, and you cite the Department's support for recently adopted code requirements that require sprinklers in most multi-family housing units from now on. Could you expand on that? Has HUD led the way, or do we now require sprinklers regardless of the local code?

Mr. HOLMAN. I wouldn't say we're leading the way. Part of OMB's Circular A-119 directs Federal agencies to participate on private sector code and standard developments, and that's exactly what we do.

For some time I was on the BOCA Basic Building Code Change Committee. I've got some staff on some of the other committees. We actively participate on these committees. We review those documents that are presented to those committees and all the research and technology that goes toward establishing proposals. With our assistance and the name of HUD behind our recommendations, it does tend to leverage the group in favor of these kinds of actions. Also, because—where there are no local or State codes, the model codes become the Department's criteria. Therefore, it tends to give more punch to the use of the model codes.

A while back, there was a question as to the amending of model codes by local jurisdictions. We find that's coming to be less and less, I think primarily because code development is a very, very difficult and expensive process, and, just like the Federal Government, the States and the local governments are under a fiscal crunch and they can't afford to redevelop every wheel, other than looking at model codes, and quite a lot of them, the communities across the country, are adopting carte blanche these models. And model codes are exactly what they sound like; they are models until accepted by a jurisdiction.

So they find that it's just a lot easier and simpler to go ahead and adopt them without changes, and therefore, as time goes along, sooner or later I think we're going to have the model codes adopted across the country with very, very few changes.

Mr. WALGREN. I gather there are areas now that would require sprinklers in multi-family and areas that would not require sprinklers in multi-family. Is that right? We don't have any uniformity in that.

Mr. HOLMAN. Correct.

Mr. WALGREN. All right. Perhaps we can explore some other areas with you in writing for the hearing record, and I think I'd like to reserve that possibility with each of you, because we do consider you a resource to the committee, and I want to thank you very much for your testimony here today.

Mr. HOLMAN. Thank you, sir.

Mr. BRAGDON. Thank you, sir.

Dr. SNELL. Thank you, Mr. Chairman.

Mr. WALGREN. The next witness, John Heslip, the president of the National Concrete Masonry Association, accompanied by several people involved in that organization that can provide some specific information to the committee: Jim Hurst, with the—a fire protection engineer; Jim Messersmith, coordinator of the Field Code Services, both with the Portland Cement Association; William Koffel, and Rick Thornberry, both professional engineers with fire protection engineering interests, and good experience in the area.

So welcome, gentlemen, to our process. We appreciate your coming, and we'd recognize Mr. Heslip at this point. We're pleased you're here, and we look forward to your testimony.

STATEMENT OF JOHN A. HESLIP, PRESIDENT, NATIONAL CONCRETE MASONRY ASSOCIATION, ACCOMPANIED BY JAMES HURST, FIRE PROTECTION ENGINEER, PORTLAND CEMENT ASSOCIATION, SKOKIE, ILLINOIS; JIM MESSERSMITH, COORDINATOR, FIELD CODE SERVICES, PORTLAND CEMENT ASSOCIATION, SKOKIE, ILLINOIS; WILLIAM KOFFEL, PRESIDENT, KOFFEL ASSOCIATES, INC., MARRIOTTSVILLE, MARYLAND; AND RICK THORNBERRY, PRESIDENT, THE CODE CONSORTIUM-FIRE PROTECTION ENGINEERS, NAPA, CALIFORNIA

Mr. HESLIP. Thank you, Mr. Chairman, members of the subcommittee. Indeed, we are appreciative of being at this event.

I would like to paraphrase our technical submission by these remarks, if you may. I'm John A. Heslip, president of the National Concrete Masonry Association, and with me are the persons that the chairman has introduced previously. Collectively, our appearance today represents seven national associations, and our written—formal written statement summarizes our position. We would be available for any questions that may arise.

We elected to call our formal statement "Is America Still Burning?" Fifteen years after the historic America Burning report jolted this Nation, we continue to experience greater fire losses than any other industrialized nation in the world. America is still burning. The claimed progress in reducing deaths due to fire since 1973 often cited and recently cited from 12,000 to 6,000 is overstated due to statistical inaccuracies. Today, we appear to have reached a plateau, and that plateau is much too high.

The gradual change in the direction of the building codes philosophy has placed the major emphasis on reducing loss of lives while essentially abandoning any effort to preserve property. Property protection is even being traded off.

Code development is being directly influenced by new trends in technology and research which we are now—now being used regularly to support tradeoffs for life safety systems while loss of property continues. Property losses in structure fires alone ranged from $4.4—5 billion in 1980—correction, $5.45 billion in 1980 to $5.84 billion in '86. Details are provided in our written report.

Unfortunately, we live with the common misconception that property loss is between the owners and the insurance company. Actually, the general public becomes the paymaster of these losses. Ninety-two percent of all structure fires are in the residential housing sector. Until we better understand the causes of fire losses in the residential structures we will continue to face this grim situation.

Our emerging technology should evaluate the fire problem in multi-family housing by using a fire risk assessment methodology. We suggest such an approach would need to address the probability of fire occurrence, the potential for harm or hazard, and the exposure of people and property. Our formal statement outlines the framework on which such a methodology could be constructed. But such an effort will require assistance from the Federal Government, such as the U.S. Fire Administration and the National Bureau of Standards Center for Fire Research, in a partnership with the private sector and the model codes and standards writing organizations.

We have also identified a potential flaw in the basic concept of fire resistance used in today's code, a concept based on technology over 60 years old. Recent research suggests that the concept of fire load and fire severity may be dangerously underestimating the real world fires. Thus, construction assemblies tested to meet this criteria may be inadequate. The fire losses in multi-family housing will likely increase from the present unacceptable rate.

We suggest adopting balanced design, a rational approach to reducing these losses, and by balanced design we mean the basic strategies of detection, suppression, and containment integrated into a total systems philosophy.

Further, the concept of balanced design recognized the importance of property protection and life safety which must be considered in defining a new strategy for fire safety. Tradeoffs can no longer be tolerated in fire safety design. The total reliance on active sprinkler and alarm systems and the elimination of passive containment systems, such as the masonry and concrete walls and floor separations, has created unwarranted risks.

The driving force behind the present trend for tradeoffs is the concern about increased construction costs. We see sprinkler ordinances adopted enthusiastically with the increased cost of such systems being accepted by trading off containment features. Fire protection for less cost is producing less protection. Recent research by the University of Michigan School of Engineering applying the life cycle costs and performance will illustrate this point, as we point out in our formal report.

At this time, I'd like to take two minutes to show you a video that I believe fairly summarizes the systems we advocate.

Mr. **Walgren**. I'll tell you what. I think maybe this would be a good point to suspend and come back in ten minutes. We have to respond to that vote on the Floor. If we do this two minutes, we'll be down to about five minutes, and maybe we should hold the video, and we'll be right back and have the balance of the presentation at that point. It's probably a good point to interrupt.

Mr. **Heslip**. Thank you, Mr. Chairman.

[Recess.]

Mr. **Walgren**. Let me call us back to order, and we were about to look at this video which, if there were a way to turn down the lights it might help, and if we could swing it a little bit so the audience could certainly see it, unless you've played it for them in the interim.

[Videotape shown.]

Mr. **Heslip**. Again, we submit, Mr. Chairman, that that is a third party testimony to the kinds of provisions for fire safety that we recommend.

I would like, in conclusion to our presentation, to point out that we presented our concerns and some solutions to the Nation's fire problems and that we believe it can be significantly improved upon through congressional leadership, and I'd like to offer the following three specific suggestions: first of all, that we would instruct the U.S. Fire Administration to adopt and actively promote the concept of balanced design; secondly, that the National Bureau of Standards establish a technical definition of balanced design so that a usable methodology can be developed; and, finally, to instruct the Government Accounting Office to conduct a cost-benefit analysis of balanced design and report its finding to Congress.

This panel believes that significant progress to reduce fire losses in this country can be attained when the three recommendations we outlined here this morning are adopted. Clearly, the whole Nation stands to benefit by the adoption of a balanced design approach.

I would just finally say that if there are issues that are unanswered today with our input, we would like to have an opportunity to submit those in the record before closing. Thank you for this opportunity to be with you this morning.

[The prepared statement of Mr. Heslip follows:]

IS AMERICA STILL BURNING ?

A STATEMENT PREPARED FOR CONSIDERATION BY
THE U.S. HOUSE OF REPRESENTATIVES COMMITTEE
ON SCIENCE, SPACE AND TECHNOLOGY -
HEARING ON FIRE SAFETY IN MULTI-FAMILY HOUSING
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IS AMERICA STILL BURNING?

1.0 CONSIDERATIONS IN FIRE SAFETY

1.1 Introduction - The Issues

During the last three hundred years or so in our history, hostile fires have been the cause of hundreds of thousands of tragic deaths and have injured and otherwise adversely affected the lives of millions of people. In addition, fire destruction of property in the built environment has been so incredibly great that it is difficult to comprehend the enormity of the physical and monetary losses.

Significant technological advancements, mainly in the area of life safety, have been made in the last 15 years by the private and public sectors of the fire protection community to improve the fire loss situation. While some improvements are in evidence, the accomplishments have not resulted in meeting acceptable fire safety objectives in a timely and substantial measure. The nation still suffers extensively from this source of deaths, injuries and destruction of property.

The purpose of this report is to provide a statistical definition of the fire problem in the United States and to render an evaluation of the data to provide a vivid view of what this national concern is all about. The report also indicates how current trends in the development of building codes have changed the ways and means by which fire safety is provided in the construction of buildings. Most importantly, it offers specific suggestions on how it can effectively help the fire protection community expand its programs in directions that would focus on certain new research and provide the technology necessary to further develop and improve building regulations in the cause of fire safety.

1.2 Codes

Often, new technologies and innovations in fire protection systems and methods for controlling, suppressing and resisting fires are introduced and implemented through adoptions as regulatory provisions in building codes. In this regard, building codes impact and frequently change the fire safety features of building construction. Building codes essentially are developed to provide a reasonable level of life safety and property protection in order to serve in the interests and general welfare of the public. However, continuing modifications to building codes generated by changes in the state of technical knowledge, changes in prevailing attitudes and code development philosophies, and the promotional interests of those involved in code development work can create fire protection inequities that serve to make some of the fire related regulatory provisions in building codes a part of the overall predicament. The sponsors of this report are of the strong opinion that this is the current situation and attempt herein to show that imbalances in code requirements contribute to the national fire problem.

For explanatory purposes there is a need here to consider the national fire problem as two separate issues: First, the problem of safety to life, and second, the problem of property protection. Both of these issues are significantly different in character from each other and, with some exceptions, each generally requires different considerations in finding workable solutions. In the end, however, the issues of life safety and property protection must be joined as a composite consideration in seeking a balanced solution to fire safety. This kind of technical evaluation should be central to code development perspectives and is the essence of this report.

1.3 Life Safety

To better understand the life safety issue, a look back into recent history is helpful. Prior to the 1960's, building codes were developed on the basis of providing reasonable fire protection to property. The idea was that if property was adequately protected from fire, then it followed that the people would also be protected. Based on the level of technology and the fire protection practices of the times, such an approach was not unreasonable. It is enough to say, however, that advancements in fire technology, the upgrading and introduction of new innovations in fire equipment and fire fighting techniques, participation by government in fire research and other programs, as well as vigorous promotions by involved segments of industry have all caused the pendulum to swing completely to the other side.

Today, life safety is considered to be the paramount fire issue in code development work. However, this reversal of priorities should not be taken to mean that there has been a simple turn-about in the emphasis on protection to life and property safety. The current situation goes well beyond that. Property protection has actually been ignored and even "traded off" in the name of life safety. It has become so obscure, in fact, that it is gradually becoming a vanishing issue in the development of building codes. Based on this nation's fire record, such a position is not justified and does not serve in the best interests of the nation.

The impetus for today's concerns on life safety from fire can be attributed, in part, to America Burning, a report of the National Commission on Fire Prevention and Control published in 1973. This report to government and the public was an elaborate presentation of the nation's fire problems and it especially served to initiate a public awareness of the terrible losses in lives. At the same time, the report was used unknowingly to publicize some misleading information that made the statistic on life loss appear far worse than it really was. Since statistical data is often employed as a basis for arguing issues and is even used here with that intent, it is necessary to set the record straight.

The America Burning report cited National Fire Protection Association (NFPA) statistics claiming that in the United States the annual death toll from fire was reliably estimated to be 12,000 people. Since current NFPA statistics show that the annual fatalities are now estimated to be about 6,000 people (all fires, including vehicles), it would appear that in less than 15 years the fire protection community was able to reduce life losses from fire by about 50 percent. Beliefs in this magnitude of reduction in life loss are in total error. Just four years after the publication of America Burning, the NFPA adjusted its 1976 statistics downward to an estimated 8,800 fatalities on account of changes in its method of estimating losses. In subsequent years, the NFPA made a further downward statistical adjustment to its annual life loss statistics, finally reaching an acceptable level of reporting confidence in the early 1980's. Therefore, for comparative purposes and reliability of data as needed to establish the numbers and the trends in life losses from fire, this report uses NFPA statistics beginning with 1980 through 1986.

The NFPA seven year U.S. record of estimated civilian deaths in structure fires for this period is summarized in the following table. The figures for 1987 will not be available until September 1988 and, therefore, cannot be included as part of this presentation.

TABLE 1

ESTIMATED CIVILIAN DEATHS IN STRUCTURE FIRES (1980 - 1986)

Occupancy	Year							7-year Average	Percent Of Total No. Deaths
	1980	1981	1982	1983	1984	1985	1986		
RESIDENTIAL: (Total)	5446	5540	4940	4820	4240	5025	4770	4969	95.28
One & Two Family Dwellings	4175	4430	3960	3825	3290	4020	4005	3958	75.80
Apartments	1025	970	860	845	785	865	650	857	16.43
Hotels & Motels	165	90	75	80	120	85	50	95	1.82
Other Residential	81	50	45	70	45	55	65	59	1.13
NONRESIDENTIAL	229	220	260	270	285	240	215	246	4.72
Totals	5675	5760	5200	5090	4525	5265	4585	5215	

Source: National Fire Protection Association

As can be seen in Table 1, the total annual average number of deaths in all structure fires in the seven year period (1980-1986) is 5,215 people. While the number of deaths varies from year to year, the trend is downward, but only slightly. Indeed the record is not wholly impressive. It indicates that over the years, very limited progress has been made toward improving the fire death situation, particularly in residential buildings where nearly all fire fatalities occur.

The average loss of 5,215 people per year raises certain questions: Is this a large or a small number of fatalities--and compared to what? Is the number of great consequence or is it really of minor concern?

In a nation of some 241 million people (1988 projection) life losses from fire would break down into a ratio of one death per year for about every 50,000 people. It is rather easy to portray the sense of this correlation. For example, anyone watching a sports event in a 50,000 seat stadium could look across to the opposite stand and pick out one, unidentifiable person as being representative of the only potential fire fatality among the gigantic mass of people attending the game. Visually, the expected life loss would not appear comparatively significant when seen as a single head in a crowd equal to the population of a modest-sized city.

The essence of this illustration is to show that when the record of fire fatalities is viewed from a frame of reference that encompasses the entire nation, the relative importance of the statistical losses appears rather small. Regardless, society in the United States deems life to be immeasurably precious and the saving of lives from fire would, without question, be considered to serve in the best interests and general welfare of the public. For this reason, notwithstanding the statistically small numbers, it is sensible to pursue and implement reasonable programs for life safety.

The greatest concern is the record of annual deaths from fire in one- and two-family dwellings and in multi-family units (apartments). These two residential occupancies account for more than 92 percent of all structure fire fatalities. Some 4,800 people die each year in household fires alone.

The National Bureau of Standards (NBS) has evaluated that if each residential unit was to be equipped with smoke detectors and a fully automatic sprinkler system, then about 73 percent (3,500 people) of the current annual deaths could probably be saved. While this projection may or may not be realistic, the costs would be staggering.

There are about 91.4 million households (1988 projection) in the United States. If each household was to be equipped with the life safety systems described above, a total capital expenditure of $110 billion or more would be required. In the period of the next 42 years, which represents the median life expectancy of the current U.S. population, it is estimated that about 147,000 lives (3,500/yr) could be saved from residential fires if this strategy were implemented. This translates into a direct cost (in constant dollars) of $748,000 for each life saved, or a total of $2.6 billion annually. Further, since there would not be a monetary payback on such fire protection installations, the loss of interest on the capital investment calculated at a straight 6 percent annually over the 42 year period would amount to a sum of more than $276 billion. What this all means is that every living man, woman and child comprising the U.S. population would be burdened with a one-time, immediate direct cost of $455 per person and, over the years, would sustain a loss of interest on the capital by an additional amount of $1,145, resulting in a total obligation of about $1,600 per person. Obviously, from a cost/benefit versus risk standpoint, this approach to life safety would not be warranted or feasible.

The National Bureau of Standards has also evaluated that if every residence was provided with smoke detectors only (which essentially serve to give the occupants early warning of fire), then about 50 percent of expected fire deaths might be prevented. This would represent a life savings of about 2,400 people per year. Table 2 gives the results of this approach in comparison with the sprinkler/smoke detector systems approach discussed above.

TABLE 2

COMPARATIVE COSTS OF RESIDENTIAL LIFE SAFETY SYSTEMS

Fire Protection System	Estimated Costs 91.4 mil Households	Potential Yearly Savings In Lives	Total No. Lives Saved in 42 Year Period	Direct Cost Per Life Saved	Total Direct Cost Per Person In U.S.
Sprinklers plus Smoke Detectors	$ 110 bil.	3500	147,000	$ 748,000	$ 455
Smoke Detectors	5.5 bil.	2400	100,800	$ 54,400	$ 23
Difference	$ 104.5 bil.	1100	46,200	$ 2,226,000	---

Table 2 shows that the direct cost of $54,400 per life saved under the smoke detector approach to life safety is only a small fraction of the comparable cost of $748,000 calculated for the sprinklers/smoke detectors method. Saving the remainder of the 1,000 people per year would result in a direct cost of more than 2 million dollars for each additional life saved and at an extra burden on the nation of more than $2.4 billion annually.

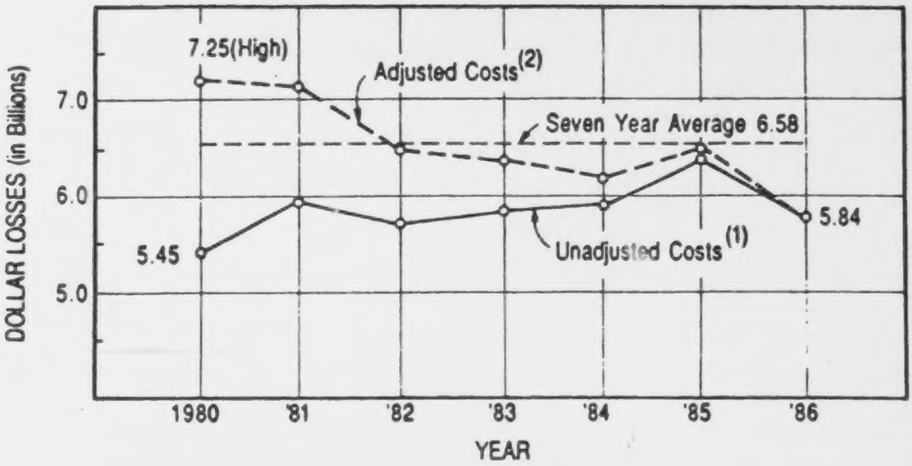
These two illustrations were purposely used to show that while the saving of lives from fire is a noble pursuit, the types of protection need to implement such a mission must also withstand economic scrutiny. It is extremely difficult, if not morally impossible, to set a dollar amount on the value of a life. But the reality is that reasonable approaches to life safety can be found as the monetary comparisons of the two illustrations given above would indicate. This was a simple analysis involving only one issue in fire safety. Obviously, the problem is made considerably more complex when the second issue, property protection, must also be considered in conjunction with life safety in order to produce a balanced solution to this nation's fire problem.

1.4 Property Protection

While the annual death toll from fire is relatively small, the destruction and damage to property caused by fire throughout the United States reaches enormous proportions. The National Fire Protection Association (NFPA) reports that in 1986 estimated property losses from fires in structures amounted to well over $5.8 billion. This is the latest statistic currently available.

The NFPA's seven-year statistical record (1980-1986) shows that property losses in the nation ranged from an estimated low of $5.45 billion in 1980 to $5.84 billion by the end of 1986. It would first appear that property losses from fire are rising, however, the figures to not account for inflation. Figure 1 shows the NFPA unadjusted figures in comparison to adjustments made to reflect fire costs in 1986 dollars.

PROPERTY LOSSES FROM STRUCTURE FIRES IN THE UNITED STATES (1980-1986)



(1) Source: National Fire Protection Association

(2) Costs adjusted for inflation to 1986 prices based on Consumer Price Index (CPI) of the U.S. Bureau of Labor Statistics

The indication is that a gradual decrease in property losses occurred in the seven-year period, but the trend is not significant when compared to the hard numbers of total annual losses. Most importantly, the statistics show that in recent times the nation has sustained direct property losses at an average estimated cost of about $6.58 billion per year measured in 1986 dollars.

While national cost statistics on property losses from fire are usually stated in megadollars, it is difficult to envision what a billion dollar loss, for instance, represents in actual buildings and contents. To get a mental handle of the association between the statistical costs of fire and the magnitude of physical losses, it would be appropriate to provide a descriptive example. For this purpose, one may cite and interpret the results of one of the most destructive fires in United States history.

The fire began on the evening of October 8, 1871 and spread quickly over an area of some 2,000 acres that included the central business district and surrounding residential communities. In 27 dreadful hours the fire storm had reduced the heart of the City of Chicago to rubble. The final toll was appalling: nearly all of the 17,000 buildings attacked by the fire had burned to the ground; 90,000 people, more than a quarter of the city's population, had been left homeless; and, as if by some miracle, only 250-300 people lost their lives, the exact count never having been established.

At the time, property losses were estimated to be about $200 million. In 1986 dollars, the Chicago fire losses would be valued at more than $1.8 billion. In 1871, today's $6.58 billion average property loss would be equivalent to the destructive effects of nearly four Great Chicago Fires. However, the costs of building construction in these contemporary times would be higher than the comparable construction costs for the relatively uncomplicated structures built in the previous century. Therefore, today, the same $6.58 billion equates to somewhat of a lesser volume of structure fires than the representative fire experiences of 1871. Albeit, property losses are enormous.

Can the likes of the Great Chicago Fire ever happen again? Because of the current state of fire protection practices and applied technology, the response would be that in these times it is virtually impossible for such a single total disaster to happen. And yet, this is figuratively what has been happening year after year.

If we could take all of the $6.58 billion worth of destruction and damage to property caused by fires throughout the United States and physically assemble them in one geographic area, it would represent the equivalent of losing an entire city every year -- a city ranging in population somewhere between 185,000 and 225,000, depending on the replacement cost of its commercial/industrial complex and other nonresidential property. How many symbolic cities the size of a Galveston, Texas, or a Vancouver, Washington, can the nation afford to lose every year to fire? Would we idly stand by as such a city was devastated?

Looking at the problem from a different perspective, the 1980-1986 NFPA statistics on residential property losses, including one-and two-family dwellings, apartments, hotels and motels, and other living facilities, indicated an average of 662,000 fires per year at an average annual cost of $3.76 billion. The average loss per fire amounted to $5,686.

The 662,000 figure represents approximately the total number of individual households in each of the following cities: San Francisco, Denver, Cleveland, Newark, Cincinnati and Kansas City. In 1986, these cities ranged in population from 1.4 to 1.9 million people. In other words, each year, we as a nation suffer fire damage to the equivalent of the entire residential area of Denver -- a monumental disaster if it were to occur all at once in one place, but no less monumental just because it is spread liberally across the Univerd States.

The attempt in this part of the report has been to put a visual scale to the immensity of the physical destruction from fire that befalls the nation on an annual basis. It has been a long-standing national problem of gigantic proportion, but the incredible fact is that the problem continues to remain in obscurity. Unlike the wide publicity that has been given over recent years to the fatalities and injuries caused by fire which has made the public acutely aware of these human losses, property destruction on the other hand has not been forcibly brought to public attention.

Part of the reason for this is that the public is generally unaware of the total magnitude of national property losses because the reporting of fire incidents by local news media usually remains local information. Only a few spectacular fires, particularly those that involve large numbers of fatalities and injuries, receive national news coverage and such events are rarely identified in terms of property losses. Further, it is nearly impossible for the vast majority of people to acquire a mental picture of what $6 to 7 billion in yearly fire losses actually represent in terms of physical destruction. Finally, there is a public misconception that the risk of property loss from fire is solely a matter between the building owners and their insurance companies and, therefore, is not a problem affecting the public domain. This outlook falls far short of reality. What is not clearly understood is that the general public is the actual paymaster for our national property losses.

However, since the fire protection community has elected to focus its efforts and publicity on life safety concerns and has, for the most part, put aside the issues on property protection. Ongoing research projects and other work programs devoted to the problems of fire safety are stated in the body of this report and clearly indicate that the emphasis is almost totally directed to the protection of life.

This imbalance in technological effort together with the predominance of publicity aimed at the problems of life safety have not only served to channel the outlooks on fire protection in a single direction, but also to change the course of code development philosophies in a supportive way. They have been used as the basis for making major modifications to building codes to the extent that some of the property protection qualities of building construction previously contained in the regulations have been traded off for adoption of life safety protection systems -- all this in the face of a deplorable record of property losses from fire.

That is not to say that change was not necessary; not that advances in the state of technical knowledge should not be used to generate and implement different ideas. The case here is simply that the course of code development activity has been so confined to the concept of life safety that regulatory inequities have been created that do not serve well in the public interest.

1.5 Balanced Design

The sponsors of this report are dedicated to finding the ways and means by which the regulatory inequities in fire protection requirements now existing in building codes throughout the country can be remedied. They intend to promote the research necessary to develop technical methodologies by which the needs for life safety and property protection in the built environment can be integrated into a common balanced solution for consideration by all concerned.

2.0 FIRE RISK ASSOCIATED WITH MULTI-FAMILY RESIDENCE

2.1 Scope

The purpose of this section is to provide an overview of the fire risk associated with multi-family residences. For the purpose of this report, fire risk shall be defined as a quantitative measure of the probability of harm from a fire based on the combination of three factors: (1) the probability of fire occurring; (2) the potential for harm (hazard); and (3) the probability of exposure of people, property, or operations.

2.2 Probability Of Fire Occurring

It is difficult to determine mathematically of likelihood of a fire occurring. However, the fire problem in residential occupancies can be quantified based on historical fire experience. As shown in Section 1 of this report, fire data clearly indicates that residential occupancies continue to lead all other types of structures in the number of deaths and property lost due to unwanted fires.

It is quite apparent from the statistics that the residential fire problem is one that warrants a great deal of attention by the fire safety community. Indeed, as they have historically, residential occupancies continue to present the greatest potential for the loss of life and property from unwanted fires. The fire problem in multi-family residences can be quantified in terms of fire incident data for 1986 which indicates that 12% of the residential fires, 14% of the fire fatalities in residential occupancies and 8% of the total dollar loss for structure fires involve apartment buildings.[1]

Until the residential fire problem is understood and adequate means of mitigating the effects of fire within residential structures are identified and enforced, we will continue to face this grim situation.

2.3 Potential For Harm

A fire may pose several types of hazards, singly or in combination, to people, animals or property. The hazards are associated with a number of fire properties of materials, products, or assemblies, including ease of ignition, flame spread, rate of heat release, smoke generation and obscuration, and toxicity of combustion products. This part of the report will concentrate primarily on issues related to fire severity, smoke production and toxicity.

Fire Severity.

Traditionally, building code requirements have been based on anticipated fire load as the primary factor in fire severity. Code required fire resistance ratings have been based on a standard time-temperature curve as defined in ASTM E119 and work done in 1917 which indicated that a fire load of 10 pounds per square foot required a fire resistance of one hour. This traditional base as well as more current research will be explored herein.

The potential severity of a fire within a residence, indeed in any structural compartment, is a function of the fire loading, the area and thermal properties of the bounding surfaces, and of the ventilation conditions. It is this potential fire severity that must be considered when attempting to specify the necessary fire resistance of the compartment boundaries. Underestimating the severity of a fire could lead to inadequate fire resistant barriers being specified and installed. However, gross overestimates of the fire severity could lead to uneconomical building assemblies.

The potential fire severity of a compartment is directly related to the fire load within the compartment. Therefore, it is essential that the fire load and characteristics of the materials be quantified. For purposes of this report, the discussion will be limited to residential occupancies and in particular, to multi-family dwellings.

In 1980, L. A. Issen made available the results of an extensive study of the fire and live loads within residential occupancies.[2] According to Issen, this study was undertaken to develop fire exposure curves which could be used to simulate fire development within single family dwellings. That same year, J.B. Fang and J. N. Breese used the Issen data during a study designed to develop a rational test procedure for evaluating the fire resistance of residential fire barriers.[3] Based on a series of 16 full scale fire tests, Fang determined that the ASTM E119 standard time-temperature curve currently used to test barriers may not be representative of fires in residential occupancies.

Since different fuels have different values for the heat of combustion, Issen normalized all values by taking the total heat that could potentially be released per square foot of floor area and dividing that value by the heat of combustion of wood which he assumed was 8,000 Btu/lb. Thus, the fire loading could differ from the live loading which is simply the weight of the fuels. For example, a wood table would have a fire load equal to its live load; but a plastic table, with a higher heat of combustion, would have a higher fire load than its live load value. Additionally, fire loads were classified as "movable" or "total". The movable fire load, in simple terms, referred to those items that the occupants brought into the structure (contents) and not those associated with the construction of the dwelling. The total fire load accounted for the movable fire load plus fixed fuel items, like combustible construction members, wall linings, etc.

Based on Issen's work, for single family attached dwellings, the following values were derived for the weighted mean of the equivalent movable fire load, and the range of the average values for the entire house:

Fire Load Of Movable Contents (lbs/sq-ft)

Mean	6.7
Range	1.4-16.8

Total Fire Load (lbs/sq-ft)

Mean	12.1
Range	6.9-25.7

Similar values were given for single family detached dwellings. This suggests that fire development within attached and detached dwellings will be the same relative to fire loading. Values for live loads were available; but as the potential heat release is not directly defined by fuel weight, they have not been included herein.

Fang's work was primarily concerned with fire development in residential basements, and in particular, the fire resistance of floor/ceiling assemblies. Therefore, in his work, Fang selected a fire load value 4.71 lbs/sq-ft as a typical value for a residential basement based on Issen's work. It should be observed that this value is only 70% of the total average reported by Issen of 6.7 lbs/sq-ft for movable fire loads.

In his report, Fang is critical of the ASTM E119 standard time-temperature curve used to test fire resistant barriers. Fang recalls that the curve was developed in 1917 based on a series of full scale tests and has been in use since that time. However, since the inception of this curve, the design and construction of residential occupancies (among others) as well as the contents have drastically changed. Presently there is a large number of synthetic materials, composites and finishes used in the contents of our dwellings. These tend to have higher heat release rates, burn more rapidly, and degrade more quickly due to the effects of fire than did the predominant wood products that were common when the ASTM E119 curve was first introduced.

As a conclusion to his report, Fang suggests a new time-temperature curve for use in testing residential fire barriers, based on his experiments, and compares this curve to the existing ASTM 119 curve. Figure 2 shows the derived curve Fang has suggested and the Standard ASTM E119 curve. It is quite obvious from these curves that the first 20 minutes of "typical" basement fire growth may be significantly greater than that defined by the ASTM E119 curve. Fang states that the curve he presents in Figure 2 may be more realistic for testing residential floor/ceiling and wall assemblies as well as columns and doors.

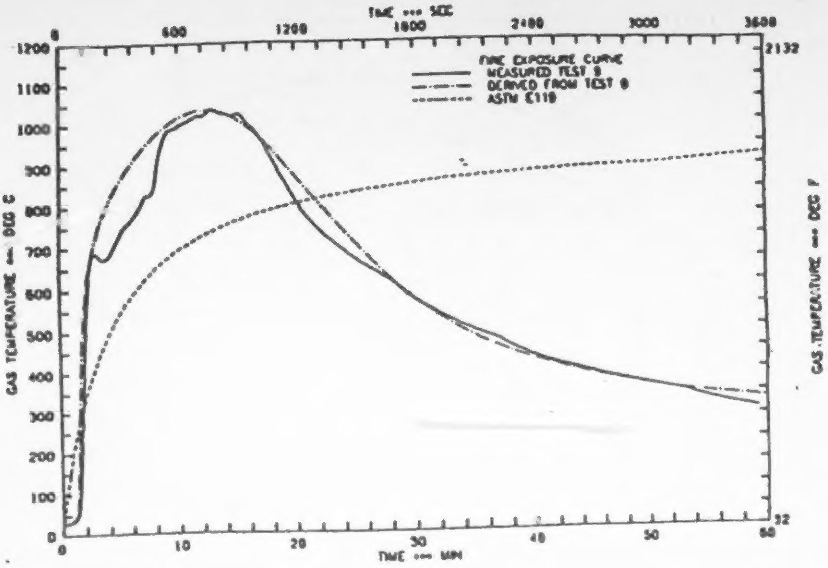


FIGURE 2

Comparison of fire exposure curve derived
from room fire test and ASTM E 119
Standard Time-Temperature Curve
(Test 9, Reference 3, J. B. Fang)

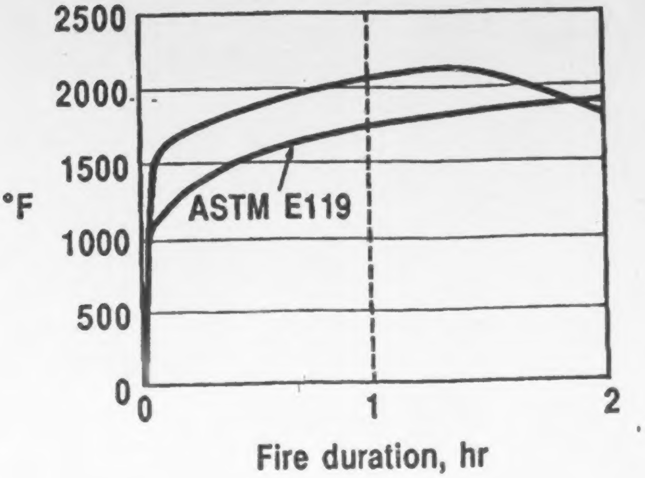


FIGURE 3

Comparison of ASTM E 119 Standard Time-Temperature Curve with actual fire temperatures (Reference 4, Lund curve - 13 psf fire load)

Work done at the Lund Institute of Technology[4], Sweden, provides further evidence of the inadequacy in applying the ASTM E119 Standard time-temperature relationship to residential occupancies. In the Lund Rational Design Method, accepted by the Swedish Building Code since 1967, real fire curves developed from specific compartment fire scenarios are used in determining fire endurance ratings of structural members.

Using the Lund Method for a total weighted mean fire load of 13 pounds per square foot of floor area, as prescribed in National Bureau of Standards Report NBSIR 80-2155, and appropriate boundary and ventilation conditions compitable with a 2-bedroom dwelling unit of combustible construction results in the real fire curve shown in Figure 3. Since increasing or decreasing the size of the unit by one bedroom has little effect on this curve, it can be considered representative of the time-temperature relationship that may occur during a fire in a typical apartment.

When compared to the standard ASTM E119 curve, it is readily apparent that actual fire temperatures represented in the Lund curve exceed those developed during ASTM standard procedures for a period well beyond 1 hour. From this, one can logically conclude that one-hour compartmentation, as prescribed in most building codes, is not adequate to resist a burn-out in a dwelling unit of a multi-family building.

Fang's work is quite thought provoking. Consider, for example, flashover. The thoughts prompted by Fang's work are many. Flashover is the critical point at which fire develops from localized burning to full room involvement, can occur within a few minutes from the inception of the fire for those compartments found in residential occupancies. Flashover results in the compartment attaining fully developed fire conditions. It is at this point that the heat release is at its maximum and the threat of the fire spreading from the compartment is the greatest.[5] Therefore, current fire barrier testing may be inadequate for the actual fire development that will occur in residential occupancies, even if installed as tested. However, it should be noted that tested assemblies are constructed under controlled laboratory conditions and rarely represent field constructed assemblies.

A further concern is that Fang's curve was based on a fire load of 4.71 lbs/sq-ft and not the average reported by Issen to be 6.7 lbs/sq-ft. This suggests the curve offered by Fang is itself less severe when considering the average fire loading throughout a dwelling and not just the basement area.

To summarize, it would appear that Fang's suggestion of a new fire test curve instead of the currently utilized ASTM E119 curve, is a valid one. In fact, Fang's curve itself might underestimate the fire growth a structural fire barrier should be capable of withstanding without failure.

Another factor in fire development is the wall lining area and thermal property effects. According to Fang's experiments, the presence of combustible wall linings reduces the average gas temperature (presumably due to dilution by the pyrolysis products, which have given off no heat but absorbed it), but increases the period of heat release as these pyrolysis products of the combustible wall lining eventually release heat through combustion. However, because of the lowered heat, the gases released by the burning wall linings will not burn completely, therefore increasing the threat of toxic gases spreading within the compartment. In other words, the temperature may be lower, but the presence of pyrolysis products which caused the reduction in overall gas temperature may dramatically increase the toxicity of the air within the compartment and other remote areas.

It should be noted that the noticeable differences in hot layer temperature due to combustible wall linings as compared to non-combustible wall linings occurs beyond flashover. Therefore, the effect of pyrolysis products on the hot layer temperature may be a moot point as temperatures capable of structural damage and certainly of causing death have already been attained. It is therefore suggested that although there may be a slightly lower temperature reached when using combustible linings, the overall destructive power of the fire, both structurally and physiologically is enhanced by combustible wall linings.

Those wall linings that are not combustible will typically create a situation where the linings have a greater ability to carry away heat from the compartment and therefore will cause a lower hot layer temperature. This is accomplished by simply reducing the energy within the hot layer due to absorption of the hot layer energy. The thermal conductivity of the wall lining material is important as it describes how much energy the walls can take away from the compartment.

Finally, with regard to fire severity within compartments, the ventilation conditions are important. These are, however, extremely difficult to predict. Many times the predominant opening which allows ventilation of a fire is a door or window, especially in residential occupancies. Quite simply, ventilation refers to the inflow of cool, oxygen-rich air and the outflow of hot, toxic, lower oxygen content products of combustion through a void in the compartment barrier. Obviously the inflow of oxygen rich air is needed to support combustion and thus allow the fire to progress. If insufficient air (oxygen) is entrained, the fire will not burn freely and will release lower levels of heat than possible but higher amounts of toxic products due to incomplete combustion. This will be discussed later in this report.

Fire severity is an important but complex topic that must be considered when attempting to provide adequate fire protection to all forms of occupancy. It becomes especially important for residential occupancies when considering the record of fire deaths and property losses associated with these structures.

Smoke Production And Toxicity.

Although exact numbers are not known, it is widely accepted that the inhalation of the products of combustion account for more than fifty percent of all fire-related deaths. "Smoke", a frequently used term, can be defined several ways. However, a common definition used by ASTM states that smoke is "the airborne solid and liquid particulate and fire gases evolved when a material undergoes pyrolysis or combustion".

Today, many synthetic materials are found in our homes. Furniture is no longer primarily cellulosic (i.e., wood). This change in the type and quantity of fuels commonly found in our homes has dramatically increased the cause of death due to toxic poisoning. Obviously, heat is also produced and must be considered as a possible cause of injury and death. These "new" materials will often have a much higher heat release rate than the cellulosic materials.

Three products of combustion - narcotic gases, irritant gases and heat - can have incapacitating, if not fatal, effects on people in a building building. Narcotic (asphyxiant) gases cause incapacitation mainly by their effects on the central nervous system and to some extent on the cardiovascular system.[6] Most of the narcotic gases primarily affect people by causing brain tissue hypoxia (reduced levels of oxygen). Irritant gases, which are perhaps more difficult to understand than narcotic gases, affect people by two methods. First, irritant gases affect our senses, such as painful effects on the eyes and also by entering our lungs and causing difficulty in breathing. By reducing vision and inducing coughing, irritant gases can hamper people's efforts to exit a building by reducing vision and causing coughing. Secondly, irritant gases can cause other problems with the lungs, such as edema and inflammation which can cause death up to 24 hours after exposure to the fire gases. Finally, heat can also cause injury and death by burning the skin, eyes and lungs. Also, the effects of burns can cause delayed death.

Carbon monoxide (CO) is the most notorious narcotic gas formed in fire. Carbon monoxide is the result of incomplete combustion and is always present in dwelling fires. The effect of carbon monoxide is that it combines with hemoglobin to form carboxyhemoglobin (COHb). This happens since the hemoglobin has a high affinity for the carbon monoxide, over that of oxygen. The net result is that the oxygen available to the body cells, those of the brain in particular, is drastically reduced. As this process is occurring, there is also the added problem of the confusion caused by the reduced oxygen. This can reduce a trapped person's ability from leaving a building by himself. Continued exposure results in death.

Hydrogen Cyanide (HCN) is considered to be the next most common narcotic gas formed during combustion. For HCN to be generated, there must be fuels present that contain nitrogen, such as acrylics, polyurethane foams, and wool. HCN effects the body by travelling to the cells, and there effecting the use of the oxygen by the cell. Therefore, HCN is different for CO in that it effects the use of the oxygen by the cell, and not the transportation of oxygen by the cell.

Hypoxia can be caused simply by the reduction of the available oxygen. As a fire progress it consumes the available oxygen and can eventually reach a point where the available oxygen cannot support life. The threat of the previous two gases is likely to be markedly more important then oxygen depletion.

Carbon Dioxide (CO_2) is also produced during fires. Although CO_2 is not considered toxic at concentrations below 5%, it is known to markedly increase the breathing rate of people, thus increasing the inhalation of other more deadly toxic gases and increasing the odds of incapacitation.

Acrolein is a strong irritant gas that has both sensory and pulmonary effects. It is generally released during the smoldering of cellulosic materials and from the pyrolysis of polyethylene.

Hydrogen Chloride is a strong irritant with both sensory and pulmonary effects. It is generated during the pyrolysis of chlorine coating materials, most notably, polyvinylchloride (PVC).

The difficulty of precisely quantifying the threat to people by the products of combustion is that the interaction of all the hazards must be considered, not one by itself. The interaction of two or more gases of hazards can be greater than the sum of the individual threats.

Another problem of assessing the toxic and irritant properties of a fuel is the conditions under which combustion takes place. Smoldering and flaming combustion of the same fuel will release different amounts of toxic gases and at different rates. A fire in a compartment can become ventilation-limited, which means insufficient oxygen is entrained into the fire to completely burn the fuel vapors emitted. Prior to ignition, any fuel that is heated significantly will emit gases in addition to those produced by material that is already burning.

Finally, people respond differently to products of combustion. Data from NFPA's investigation report of the Westchase Hilton Hotel Fire, which occurred in March 1982 and resulted in the deaths of 12 people, shows that varying levels of toxic gases were found in fire victims found side by side. In one room, the percent of carbon monoxide found in the victims ranged from 18 to 40 percent; in another room, the cyanide levels ranged from 0.22 to 10.0. Although some of the difference is attributed to the victim's activity up to the point of death, the difference is likely the net effect of several conditions.

Smoke movement within a building is a major concern. Many times, those who succumb to fire gases are not burned and are actually found remote from the active burning area. Indeed, all the victims of the Westchase fire mentioned above were in rooms that had little to no direct fire damage with the exception of the hallway door. This was also the case for a great many of those who perished in the MGM Grand Hotel fire.

Smoke travel is important to understand as it carries the deadly gases to areas remote from the fire generating the gases. Smoke travels through buildings due to four main forces: (1) buoyancy due to difference in internal and external temperatures; (2) buoyancy created by the fire; (3) effects of external wind and air movement; and (4) air handling systems within the building.[8]

Also, the heated air expands to a larger volume which will cause movement. Smoke can travel far in advance of the fire. Regardless of the motivating force, smoke must have some pathway through which it can travel. If these pathways can be eliminated, so will the smoke movement; and hence, the deaths which could be caused by the smoke.

2.4 Probability of Exposure

This report focuses on three exposure factors related to multi-family residential fires and investigates occupant factors, fire service risks and exposure fires. The hazards associated with these exposures were explored in the previous section.

Occupant Factors.

Children, elderly persons and those who suffer from a disability are at a much greater risk from fire than the remaining population. Karter reported that between 1978 and 1982 about 78% of all civilian fire deaths occurred in the home and that certain groups were at a higher risk.[9] Elderly people, those 75 and over, had the highest fire death rate of 65.7 per million population. This rate is twice that experienced by those in the 65 to 74 age group and a staggering four times the rate experienced by the 20 to 49 age group. It should be noted that the 75 and older group is the fastest-growing in the nation. The next highest age group was that of the five years old and under. This group had a reported death rate of 53.2.

Disabilities also play an important role in fire death rates. Disabilities can be categorized in three groups: (1) sensory problems such as deafness and blindness; (2) problems of mobility such as being bedridden or requiring a wheelchair; and (3) intellectual problems such as mental retardation. Levin and Nelson suggested that problems of fire safety for disabled persons is situation-specific. They provided an example of a deaf person sleeping alone in a hotel is quite different than the same person in an office building with co-workers present.[10] Fire safety strategies must consider this. Karter reported that 18% of those victims 75 and over were bedridden. This can be coupled with statistics showing very old victims are often involved with the ignition of the fire, i.e. improper use of smoking materials.

A large percentage of young children that died during daytime fires suggest that there is a problem involving proper supervision of very young children. Very young children and infants are effectively immobile due to size, strength and motor coordination. Again, the very young are often directly involved with starting the fire that results in their death, i.e. playing with matches.

Specific data regarding the effects of sensory disabilities of the fire death rate experience by such persons were not found. However, there is no question that special considerations must be given to these people. A deaf person cannot hear an audible warning such as a smoke detector alarm or an evacuation bell, and a blind person cannot see the exit signs. The effects of alcohol or drugs on a person's ability to respond to the threat of fire is also of concern. An otherwise healthy and responsive person can become severely incapacitated by the effects of these substances. Mental disabilities can also render an individual incapable of understanding the threat of fire and being able to properly react to the threat, if it is perceived.

Without question, there is a sincere cause for concern regarding the high fire death rates experienced by the young and old and of those who are disabled.

Exposure Fire.

Any structure that is involved in fire presents the threat of ignition to other nearby structures due to radiative and conductive heating. Flying brands are also capable of causing other structures to catch fire. For a structure to ignite from an exposure fire, it must present exposed combustibles and these must be heated to their ignition points. A graphic example of the threat of exposure fires was provided in July 1979 when 22 apartment buildings were destroyed and another 4 damaged by fire spreading across the tops of the buildings by feeding on the exposed wood shingles.[11] In this incident it is likely that radiative and convective heating and flying brands were all partly responsible for the size of the fire. Distance between buildings was as much as 80 feet, but the fire still crossed this distance. Incidents have been recorded where the radiant heat from a fire ignited a building as far away as 100 feet.

Another mode of fire spread of importance is exterior fire spread of the building in which the fire originated. In the case, the fire is vented from a compartment and travels up the exterior of the structure and re-enters on another level. The exterior surfaces need not be combustible to allow this mode of fire travel. However, exterior surfaces which are combustible will result in a much accelerated vertical spread of the fire. In 1973, Brannigan presented the results of a fire study of multiple family dwellings which were not of fire-resistive construction.[12] A portion of the results regarded exterior extension of fires. Among his observations on exterior fire extensions were the following:

* combustible balconies and separation
assisted in vertical spread of fire

* plastic shutters ignited and dropped to spread the fire in a downward direction

* wooden paneling in the spandrel section between windows allowed vertical fire extension

* windows which extended away from the wall and fitted with plywood allowed fire from lower floors to enter upper floor apartments

* some buildings have fire resistive exteriors which are defeated by combustible dormers which traveled the height of the structure.

In one incident, a fire department credited a concrete balcony with preventing vertical fire spread from a severe fire. It must be understood that fire is just as likely to spread via the exterior of the structure as it is within. It must be remembered that the threat of ignition and spread of fire on the exterior of a structure is a serious one. Ignition could come from a fire within the building itself, or from a fire in another building.

Fire Service Risks.

Fire service risks can include time of duty deaths and fire service injuries. NFPA data show that between 1977 and 1986 an average of 130 firefighters died in the line of duty per year.[13] However, the same data show that between 1982 and 1986, the number of line of duty deaths has been steadily lower with an average of 117 deaths per year. The following review of firefighter deaths will be based on data for 1986. In that year, 113 line of duty deaths were reported.

Less than 40% of the line of duty deaths occurred during firefighting operations. Although this figure represents the largest percentage for the type of duty being performed, it is closely followed by responding/returning from the fire scene (35%). Heart attacks continue to be the leading cause of firefighter deaths and contribute to more deaths than all other causes combined. Of the 45 fireground deaths, 26 were due to heart attacks. Thirteen of the 39 deaths that occurred during responding or returning were the result of heart attacks. Of the 50 heart attack victims, 5 had prior heart problems and another 11 had known severe arteriosclerotic heart disease. It is interesting to note that over 50% of all fire related civilian deaths are attributed to the products of combustion but less than 15% of the firefighter deaths are.

The statistics on fire ground deaths according to fixed property use show that residential fires account for 38% of the 45 fireground deaths. Over half of these (10) were at one and two family dwellings. This is not surprising given the high percentage that residential occupancies represent of the total fires. The next largest percentage by property use is that of brush and forest fires where 18% of the fireground death occurred.

A comparison of the statistics regarding deaths and injuries show a clear divergence of the two. Fireground activities lead in each category but responding/returning which was a close second in firefighter deaths was contributed to the fewest firefighter injuries as reported in the data analysis. Perhaps a description of the severity of the injuries reported would allow a more applicable comparison between the death and injury statistic.

The injuries suffered at fire scene were as follows: 28% were due to sprains and strains; 24% were due to wounds, cuts, bleeding and bruises; and 14% were due to smoke and gas inhalation. Sprains and strains also accounted for 45% of the non-fireground operations. This shows that the majority of the injuries are in fact non-life-threatening. The life-threatening injuries would likely correlate much better with the statistics regarding firefighting deaths.

Causes of injuries sustained at fire scenes were primarily due to exposure to fire products (23%) but this was closely followed by falls and slips (21%). Overexertion was next (15%) and was closely followed by those injuries caused by stepping on or other contact with objects (15%). Injuries caused by being struck by an object accounted for 11%. The remaining injury causes were grouped as exposure to chemicals or radiation (6%), extreme weather (2%), caught/trapped (1%), and others (7%).

No statistics were present that described the frequency of injuries associated with residential occupancies. However, it is likely that these would again present the highest percentages based on the large percentage that residential fires represent of the total fire problem.

More careful studies are also needed to properly address the injury problem. Of the 15% of the fireground injuries resulting from smoke or gas inhalation, it is not known how many of them were sustained by personnel using breathing apparatus. It could be that many were not using such apparatus; but if they were, this could significantly reduce the number of fireground injuries. Reduced staffing will likely expose firefighters to increased risk of injury or death.

Obviously a reduction in emergency responses by fire service personnel will also reduce the number of fire service injuries and deaths. A reduction in the magnitude of a fire would also result in an injury/death reduction since the greater the fire, the greater the numbers of apparatus and firefighters responding to it. Because the majority of structural fires occur in residential occupancies and since such occupancies are also the leading location of firefighter deaths and injuries, a reduction in the fire incident rate and the magnitude of fires occurring in these occupancies would result in many benefits -- including a marked reduction in firefighter injuries and deaths.

2.5 Summary

This section, which is primarily based on a review of the literature, indicates that the fire risk in multi-family residences can be based on the probability of harm from a fire. In general, the three factors which can be used to quantify the fire risk are: (1) the probability of fire occurring; (2) the potential for harm (hazard); and (3) the probability of exposure of people, property, or operations.

A review of recent fire incident data not only indicates the severity of the fire problem but also indicates the risk that the fire frequency represents to the fire service in terms of firefighter deaths and injuries. Other risk factors explored include:

- Fire severity
- Fire load
- Heat release rate
- Combustible nature of wall linings
- Fire properties of the contents
- Toxicity of the products of combustion
- Smoke production
- Smoke movement and speed
- Occupant mobility
- Occupant response
- Combustibility of construction (interior and exterior)

3.0 BALANCED DESIGN

3.1 Introduction

The protection of a building, its contents and occupants from the hazards of fire remains a paramount concern of today's society. The manner in which this protection is ultimately provided must be based upon a combination of experience and technology tempered by economics. The goal of effective fire protection should be to reduce the direct impact of building fires upon individuals as well as the indirect costs of fire protection to society.

The direct impact of building fires includes personal injury, loss of life, loss of property, loss of income, and disruption of home life. There are also indirect costs incurred to protect against the impact of fire such as costs to satisfy fire protection requirements mandated by building and fire codes, insurance, fire suppression forces fire departments), water supply systems, etc. A sound fire protection strategy must be based on objectives which will reduce this negative impact of unwanted fire on this country's human and material resources.

As discussed earlier, recent fire history in this country indicates a disproportionately large number of fires and fire deaths occur in single and multi-family residential buildings. In 1986, 4,770 people died and 3.5 billion dollars in property losses occurred as the result of residential fires.[14] This represents 95% of all fire deaths and 61% of all property losses due to building fires. In order to reduce these unacceptable losses, rational fire protection approaches must be developed and implemented in the design and construction of residential buildings. Such approaches must consider traditional fire protection methods integrated with new technology to achieve long term human and economic benefits in what can be considered a method of balanced design.

The term "balanced design" can be looked at in two different ways. One is by the appropriate use of both active and passive fire protection strategies which, when properly combined, complement each other so as to reduce the probability of failure and achieve a reliable, effective solution to the fire problem. This results in a balanced approach so that total reliance on one method of fire protection does not occur. A simplified example might be the use of 2-hour compartmentation walls and floors (passive) in conjunction with automatic smoke detection systems (active) to protect multi-family apartment buildings.

The other balanced design approach recognizes that property protection is as appropriate a fire protection design goal as life safety. So fire protection approaches should not overemphasize life safety while down-playing property protection, thus resulting in an unbalanced design. Improper use of trade-offs, such as eliminating the 2-hour compartmentation in a multi-family apartment building when an automatic sprinkler system is installed in an effort to encourage life safety practices, should not be condoned at the risk of suffering even greater property losses due to fire.

A fire risk assessment methodology should be employed to develop a cost-effective approach to fire protection. Balanced design is a key component of this approach.

3.2 Fire Protection Approaches

Humans have developed two general approaches to protect himself and his property from unwanted fires. They are categorized as active and passive methods of fire protection.[15] When used together, they represent the balanced design approach to effective fire protection. Such an approach is generally synergistic, i.e., the net result is greater than the sum of the impact of the individual components both in terms of greater protection and increased probability of success.

Active fire protection relies on people or mechanical/electrical devices to detect an unwanted building fire and to intervene in the control or suppression of such a fire. It may also incorporate occupant notification and protection methods. Examples of active fire protection include: fire detection systems, automatic fire extinguishing systems, evacuation alarm systems, mechanical smoke control systems, and manual fire suppression provided by the fire department.

Passive fire protection limits the spread of an unwanted fire as well as its direct impact on a building, its occupants and contents. This is accomplished through control of building size, use, materials of construction, and compartmentation. Examples of passive fire protection include: limits of building height and area based on the structural fire resistive integrity of the construction elements; the subdivision of buildings into compartments with fire resistive barriers; the provisions for remote exits from the building accessed via fire resistive enclosures; and the use of areas of refuge separated by fire resistive barriers.

Traditionally, passive fire protection has been the basis for requirements found in the model building codes developed in this country. In the past, active fire protection was largely provided by human resources in the form of manual fire suppression by the building occupants or fire department. More recently other active fire protection methods such as automatic sprinkler systems and smoke detectors are gaining momentum in use throughout the country, especially in residential buildings.

There is an underlying assumption in the model building code requirements that fire-fighting resources are generally available to the local community within a reasonable period of time. The reliance of the codes on manual fire suppression to supplement the passive built-in fire protection is intended to provide a level of fire safety acceptable to society as a whole. However, the model codes do not recognize the fire fighting capabilities of different communities. For this reason, automatic fire protection features such as automatic sprinkler systems and smoke detection systems have found their way into the codes in an effort to reduce the variability of human based fire protection resources.

Furthermore, the model building codes' intent to prescribe minimum fire safety standards for the public benefit is vague and general and can actually be a hindrance in determining specific design objectives for fire protection. This predicament largely results from the political realities of the code change process.[16] The code's specific intent can not always be readily discerned so, in effect, the target of reasonable safety is not well-defined. This leads to design by committee. Since there is no rational basis for establishing minimum levels of safety, there is no effective method for evaluating the amount of fire safety a code provides. Many times "acceptable" methods of design or new prescriptive model code requirements are the by-product of a tragic event rather than a rational engineering approach supported by fire testing, research, and fire experience data.

Therefore, it is important to define objective goals for reasonable life safety and property protection and then design buildings to meet these objectives based on the interaction of various active and passive fire protection approaches: a total system approach using a balanced concept design.

Such a method was developed by the General Services Administration (GSA) in the early 1970's. This method is a "completely described analytical system for probabilistic evaluation of the expected success and total performance of fire safety in buildings".[17] This method is found in Appendix D, "Interim Guide to Goal Oriented Systems Approach to Building Fire Safety" of the GSA Handbook, Building Fire Safety Criteria.

The recent evolution of computer fire models developed in part by the National Bureau of Standards Center for Fire Research now provides fire protection practitioners with a deterministic rather than a probabilistic approach to rational fire protection design. The future of balanced design will be greatly influenced by such new fire protection tools which allow a designer to predict the interaction of active and passive fire protection features.

3.3 Trends

Recent trends in fire protection can be identified which have an impact on the balance of active and passive fire protection elements utilized in the design and construction of multi-family residential buildings. These trends include the use of automatic smoke detection, smoke control, and residential sprinklers based on quick response sprinkler technology and associated trade-offs of other fire protection elements such as passive protection features. Although these trends may appear to be improving the overall level of fire protection provided, they may actually lead to a lessening of safety due to the high reliance on active mechanical/electrical systems. The reliability and experience record of these new technologies and systems have yet to be shown.

Further, lessening of overall fire protection provided may occur when "trade-offs" of more traditional fire protection practices are enthusiastically encouraged in order to make these new systems more palatable from a cost standpoint. The perception is more protection for less cost. The actual impact may be less protection for less cost.

Residential fires have been responsible for the greatest number of fire deaths and injuries in the Unites States for many years. The goal of reducing this human toll coupled with the new technology for quick response sprinklers has led to the development of a relatively new standard, NFPA 13D, "Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings." The primary intent of the residential sprinkler system is to intervene in the early stages of fire growth to reduce the potential for injury or loss of life. Also, there are new provisions in the 1987 edition of NFPA 13 "Standard for the Installation of Sprinkler Systems" specifically addressing the protection of residential portions of buildings. A spin-off of this approach is the proposed standard presently under development, NFPA 13R, "Standard for the Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height".

NFPA 13R is presently being developed by the NFPA consensus process to meet the needs for a cost-effective approach to automatic sprinklers in multi-family residential buildings. This proposed national standard should help to reduce the inconsistencies of design requirements being developed by local jurisdictions throughout the country in order to respond to the concerns over added costs. This should improve the ability to provide a consistent balance of fire protection in these types of buildings, but only if the reduction in the level of sprinkler protection represented by this standard is recognized and understood.

The ability of these residential sprinkler systems to reduce the loss of life has generally been interpreted from full scale fire tests conducted during the past 10 years. The voluntary and required installations of residential sprinkler systems are dramatically increasing throughout the country. A potentially dangerous trend is the willingness of authorities having jurisdiction to modify the provisions of the sprinkler standards to encourage the more economical use of such sprinkler systems which may not perform up to expectations. Thus, they emergence of NFPA 13R to respond. The actual impact of such systems in reducing life loss and injury will not be known until such use becomes more widespread and sufficient time has passed. These systems are considered an active fire protection approach.

To further encourage the use of automatic fire protection systems such as automatic sprinklers, changes in model building codes and decisions by local authorities have allowed the trade-off of other fire protection requirements or features in an effort to offset the cost of an automatic fire suppression system. For example, the Uniform Building Code published by the International Conference of Building Officials states that when a complete approved automatic sprinkler system is installed in a high rise residential building, the following modifications (trade-offs) of code requirements are permitted:

1. Compartmentation of floors by 2-hour walls into areas less than 15,000 square feet is not required.

2. The fire resistive requirements for interior bearing walls, exterior bearing and non-bearing walls, roofs and the beams supporting roofs may be reduced by one hour.

3. Vertical shaft enclosures including elevator shafts but excluding stairs may be reduced to 1-hour.

4. Interior non-bearing partitions required to have 1-hour fire resistive construction (except for corridors) may be constructed of noncombustible construction without a fire resistive time period.

5. Fixed tempered glass may be used in lieu of openable windows or mechanical smoke control systems of smoke control purposes.

6. Travel distance to an exit may be increased from 200 feet to 300 feet.

7. A manually operated fire alarm system is not required.

8. Fire-resistant spandrel walls or eyebrows used to prevent vertical fire spread via the exterior windows are not required.

9. Fire dampers are not required.

10. Emergency escape/rescue windows are not required.

The other model building codes allow the reduction or deletion of passive fire protection features when an automatic sprinkler system is installed. Examples of this include: an increase in the maximum building area or height which, in effect, is a reduction in required fire resistance; an increase in the maximum separation of exits; omission of protected exit corridor enclosures; and the reduction of the fire resistance of assemblies providing building compartmentation.

As suggested above, the model codes also allow active fire protection features such as manual fire alarm or automatic smoke detection systems to be reduced or eliminated when sprinklers are installed.[18] Examples of this include the elimination of manual fire alarm or automatic smoke detection systems or fire dampers.

These "trade-offs", or exchanges, are presumably based on the assumption that an equal level of fire safety will be provided by the automatic sprinkler system, for example, when compared to the level of safety offered by the passive or active fire protection systems "traded-off".

Despite the cost reduction incentive of these trade-offs to encourage the use of sprinklers, the long-term fire protection benefits versus potential fire losses must always be considered. At this time, there is not a good statistical basis for determining the long term benefits or losses resulting from such trade-offs in residential buildings. Thus, the fire protection community should tread lightly when considering such trade-offs.

Another fire protection design feature which has recently become "popular" in the fire protection and code development communities is smoke control. By far the leading cause of fire deaths in this country is attributed to the by-products of a fire which include smoke and toxic gases.[19] Also, large quantities of smoke generated by a relatively small fire can cause considerable property damage. Therefore, it is important to consider means by which the smoke from a fire can be controlled within a building.

Present methods of smoke control include both active and passive approaches. Fire resistive barriers can be used to create compartments which limit smoke movement beyond their boundaries (passive approach). Mechanical exhaust systems can be designed to exhaust smoke (active approach). Pressure differentials created with fans can work in concert with the passive enclosures to further contain smoke within a designated area or prevent its incursion into areas of refuge or exit enclosures. Mechanical systems can also be designed to assist natural smoke removal through vented openings to the exterior.

Again, the use of an active fire protection system such as a mechanical smoke control system has been allowed by model building codes to offset the removal of passive fire protection features. For example, where floor-by-floor smoke compartmentation and corridor enclosures are violated in a building containing an atrium, a mechanical smoke removal system is allowed to be used in conjunction with complete automatic sprinkler protection to prevent smoke migration into exit paths and floors remote from the fire floor.

An evolving trend in fire protection is community master planning. The concept of community master planning for fire protection incorporates a balanced approach of active and passive fire protection features on a much larger scale. One approach in master planning of this type is to achieve a balance between building size and type of construction which are passive features and automatic fire suppression/detection systems and manual fire-fighting resources (local fire department) which are active systems.

A reduction in manual fire fighting equipment and manpower may be justified by limiting building construction and size. However, the existing building stock must also be taken into consideration. At the very least, in developing communities the growth of fire suppression forces could be held in check by such planning. For instance, the construction of new buildings in a community or developed area within a community might be limited to the use of noncombustible construction. Also the buildings could be limited to a maximum size with larger buildings being subdivided with firewalls. Since the cost of creating or maintaining public fire departments is very high, a master planning approach can be very cost effective in meeting fire protection goals. Then, it may be appropriate to apply retroactive requirements for active fire protection system installations in order to reduce the level of fire suppression forces.

3.4 The Future

The national trends in fire protection previously identified will have a significant impact on the future fire record in this country. It is therefore important to understand the potential effects of these new fire protection approaches and trends.

The proliferation of sprinkler requirements for new construction of residential buildings will most assuredly reduce the incident of fire deaths and injuries and the severity of property loss in those buildings which are so equipped. However, it is unlikely that the cost of sprinkler installations in all existing single and multi-family residential occupancies can be justified. The solution provided with sprinkler protection must be considered long term as the existing housing stock is replaced. Since many of the residential fire deaths in this country occur in low-cost or poorly maintained housing units, sprinkler installations in new housing will provide no immediate protection to the people who live under such conditions.[14]

The long-term prognosis for sprinklers in residential buildings is not easily determined. Any mechanical system, such as an automatic sprinkler system, must by properly maintained to assure its operation throughout the life of the building. However, proper maintenance cannot be assured and, therefore, it is reasonable to assume that the reliability of such systems will decrease over time, which would increase the probability of failure.

The reliability of sprinklers has been proven to be very good when used in commercial and industrial applications. This record highlights the importance of regular inspection and maintenance of these systems which is normally required by industrial insurers, local fire departments, or corporate fire protection policies. When failures have occurred with these systems, poor maintenance and inspection have generally been the cause.[19]

The proper inspection and maintenance of sprinkler systems in residential buildings would appear less likely to occur since individual home or building owners would have to assume the responsibility for such actions. The NFPA Fire Protection Handbook, 16th Edition, lists 40 items which require attention for the normal maintenance of a fire sprinkler system. It seems unlikely that most homeowners can provide proper maintenance. Clearly, a cost-effective and practical method for providing regular inspection and maintenance of residential sprinkler systems must be developed to assure long term reliability.

Another active fire protection feature, smoke detectors, have been required in single and multi-family residential buildings during the last 10 years. The performance of the smoke detectors can be shown statistically to have reduced the number of fire deaths in residential buildings. At the same time it should be noted that requirements for other active or passive fire protection features were not reduced as a trade-off for the installation of smoke detectors.

Proper maintenance of these smoke detectors must still be considered. Recent statistics indicate that smoke detectors in residential buildings are beginning to fail to operate during fires due to the lack of proper maintenance of the detector.

Requirements for sprinklers in new construction must be based upon rational judgement considering the overall fire protection goals of a community or nation. Quick acceptance of substandard or untested sprinkler system designs or the willingness to "trade off" active and passive fire protection features just to mandate sprinkler protection for the sake of sprinkler protection must be avoided.

A residential quick response sprinkler system is primarily intended to protect life and reduce injury. Residential sprinkler systems were developed to protect the lives of the occupants in the unit of origin with the exception of the individual who may be intimately involved with the fire ignition sequence. These systems are not, however, designed to protect property. Therefore, other fire protection features which preserve property such as fire resistive construction and compartmentation should not be casually traded-off.

The installation of active fire protection systems such as automatic sprinkler systems will influence the balance of fire protection within any building. The net increase in life safety and property protection provided by such systems is not easily measured, but arguably improved. This presumes that the other fire protection features remain in place.

However, this likely increased level of protection provided by one system should not automatically justify a reduction in or elimination of other fire protection features such as compartmentation. Complete reliance upon an active fire defense such as an automatic sprinkler system at the expense of passive fire protection such as compartmentation is unwise. Should a failure occur with the active system, a fire within a building could grow unchecked. The type and quality of the remaining passive fire protection methods incorporated into the building design then come into play to control the fire impact.

If trade-offs of structural fire resistance are utilized, what remains is a highly combustible, unprotected building -- all the more reason that passive protection should be a primary consideration, thus guaranteeing that some form of protection will always be present. Active protection should complement passive protection, not replace it.

The same problem exists with the promulgation of smoke control requirements which solely depend on either active or passive approaches. The use of an active smoke control system may enhance a building's overall capability of handling smoke in an emergency, provided the building is protected with an automatic sprinkler system. However, if the passive smoke control that is normally provided by compartmentation is compromised or eliminated, a single failure of the active smoke control or sprinkler system could create an unacceptable hazard from smoke.

Many of this county's major fire disasters as well as the hundreds of residential fires which occur every day implicate the improper design, construction, maintenance, or failure of active and passive fire protection systems as factors contributing to the spread of fire.[20] This suggests there is a need to improve these fire protection measures on all fronts. A reduction of any fire protection element without an improvement in the performance of the remaining elements can only contribute to an overall reduction in the level of fire protection provided in the building. This does not seem acceptable based upon this country's fire record.

Since the objective of good fire protection is to reduce both human and economic losses associated with fires in residential buildings it is important to promote a method of balanced design utilizing both active and passive fire protection approaches. New technology should be used prudently to enhance fire and life safety. Improvements in incorporating proven technology into the design, construction, and maintenance of new and existing fire protection systems and methods, rather than reductions in fire protection requirements, should be made in order to maximize protection in residential buildings.

4.0 AFFORDABILITY

Despite a decline in the volume of new construction over the last couple of years, multifamily housing starts still represent a significant portion of the building industry. In 1987, multifamily construction starts of buildings containing 5 or more units totalled about 327,000 units, with an estimated value of $14-15 billion.[21] Forecasts for the next 2 years indicate similar numbers, but the choice of building materials has yet to be decided. The time has come to act on this country's fire problem and provide the public with a more fire safe alternative for construction of multi-family housing.

Concrete and masonry constructed low-rise multi-family buildings not only meet this demand, but do so in a way to economically benefit both owners and occupants. Savings by owners, which can be passed along to tenants, are mainly attributed to: discounted insurance premiums as a result of the insurance industry's long-term recognition of concrete and masonry's inherent fire resistance; greater equity build-up; and reduced maintenance costs over time.

It is a common perception that concrete and masonry construction are too expensive for the low-rise residential market. However, findings from a University of Michigan study[22] coupled with cost estimates from Chicago-area precast concrete producers, builders, and sprinkler contractors indicate otherwise. In a cost comparison between a 3-story wood-frame structure and one constructed of concrete and masonry, the initial cost differential is only $3.20 more per sq. ft. for concrete and masonry, when both buildings are nonsprinklered. For sprinklered buildings, the cost differential becomes even less ($3.05 per sq. ft.) because sprinkler installations are more expensive in wood-frame buildings. When these and other savings associated with concrete and masonry are examined over time, the difference in initial construction costs between the two types of construction becomes relatively insignificant.

The following case study analyzes the long-term financial benefits of concrete and masonry low-rise multifamily housing from an owner's perspective. Such benefits would also apply to government owned buildings.

EXAMPLE: Cost Comparison of Concrete and Masonry versus Wood-Frame Low-Rise Multi-family Buildings - Nonsprinklered Analysis

GIVEN: Two 3-story buildings of identical size and shape. One building is wood-frame construction with 1-hour rated separation floors and walls and an unrated wood truss roof. The second building is a fire resistive structure with 2-hour rated concrete or masonry separation walls and concrete floors and roof. Each contains ten, 1008 square foot units per floor, totalling 30 units. All units consist of 2 bedrooms, a kitchen, a living-dining room, and a bathroom (see Figure 4). Floor to floor heights are 8 feet.

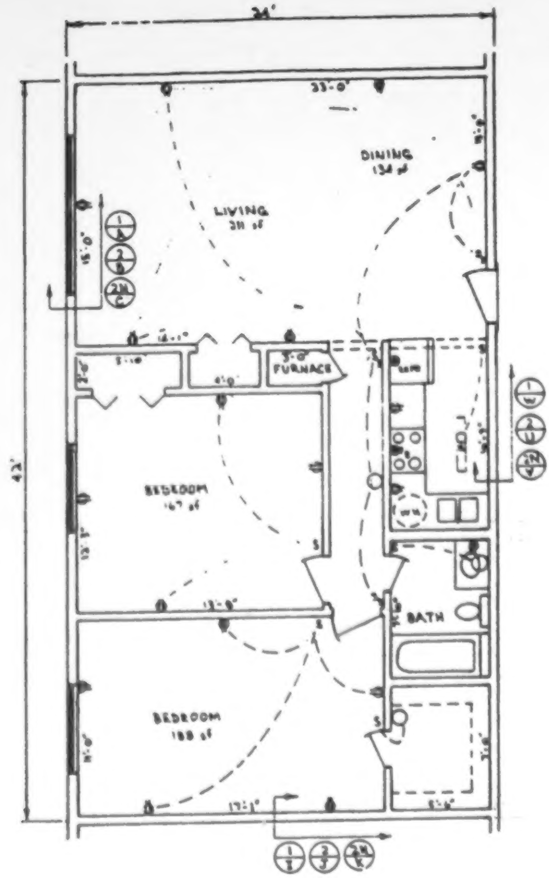

24'
33'-0"
DINING
134 sf
LIVING
211 sf
15'-0"
42'
FURNACE
BEDROOM
167 sf
13'-9"
BATH
BEDROOM
188 sf
17'-1"

FIGURE 4

Example apartment unit, entry off a corrider.

Assumptions or Basis of Analysis:

Construction Costs -

Wood-frame building - $1,228,651 (calculated from an approximate average sq. ft. base cost of $40 per sq. ft. from 1987 model code publications)(23)(24)(25)

Concrete and masonry building - $1,325,419 (from University of Michigan study[22], based on $3.20 per sq. ft. construction cost difference between the two buildings.)

Replacement cost building values for both buildings escalate at a rate of 5% each year (rounded from 5.2%) based on a 30-year average from Marshall and Swift's Valuation Quarterly.(26)

Physical (not economic) depreciation rates for the wood-frame building are taken from Marshall and Swift Valuation Quarterly table based on a 45-year life expectancy. Rates for the concrete and masonry structure are based on a 55-year life expectancy table in the same source.

Insurance Costs -

Wood-frame building - Overall insurance rate of $.453 per $100 of value, based on a 10-year average of the combined building, contents, and extended coverage rate provided by an Illinois domiciled insurance company. Rates are based on 80% coinsurance and $1000 deductibles. Loss of Rent rate is based on a typical factor of 63% of the above rate. Limits are 100% values for Building and Loss of Rents coverage. Limits applicable to the owner's contents are ignored.

Concrete and masonry building - Rate of $.083 per $100 of value. Same criteria as above applies.

Premiums increase 5% each year including inflation, over the 30-year analysis period. (4.3% due to the average escalation of actual cash building values over the last 30 years - from Marshall and Swift's Valuation Quarterly; 0.5% due to the escalation of insurance rates over a 10-year period; 0.2% attributed to additional premium generated by the Loss of Rent limit increasing every year at the average rate of inflation (4.4% over the past 35 years from 1987 Consumer Price Index Tables)[27].

Property Taxes -

Property taxes are assessed and adjusted every 4 years based on a tax multiplier of .06 times the actual cash value of the building. Taxes are assumed to remain fixed between tax assessment periods, and the tax multiplier is constant for the duration of the 30-year analysis period.

Mortgage Costs -

For both buildings: 10% fixed-rate mortgage amortized over 25 years; no balloon payments; 80% loans; and 3% loan points (included in initial cost).

Wood-frame (Annual Principal & Interest)...	$107,213
Concrete & Masonry (Annual P&I)............	$115,660

Life Cycle Cost Parameters -

Number of periods (years) analyzed = 30
Nominal discount rate (including inflation) = 7.4%
    Cost of borrowing money = 3.0%
    Inflation = 4.4% (based on 35-year average)

Other Considerations -

Initial gross income is based on a break-even analysis, whereby the building owner has a zero net income after expenses and debt service. Initial annual gross incomes are:

Wood-frame Building	$219,172
Concrete and Masonry Building	$234,401

Operating expenses are identical for both buildings and are assumed to escalate at the rate of inflation. Therefore, they do not enter into the comparison. These assumed annual expenses are as follows:

Fuel	$ 22,000
Electric (common areas only)	$ 2,000
Disposal	$ 1,200
Supplies & maintenance	$ 4,500
Janitor	$ 8,000
Water	$ 3,000

The following elements are analyzed and compared:

- Initial Costs (Construction cost plus 3% loan points)
- Mortgage Costs
- Property Taxes
- Insurance Costs
- Rental Income
- Equity Build-up

Determining life cycle cost effects on the above elements using fundamental economic analysis, their present worth is calculated for both buildings (see Figure 5). Differences in these values of a per unit basis are shown below. Positive values indicate a comparative savings with the concrete and masonry structure. Negative values indicate comparative losses.

$P_{\text{initial}} = -\$\ 722$

$P_{\text{mort.}} = -\$\ 3{,}159$

$P_{\text{taxes}} = -\$\ 2{,}805$

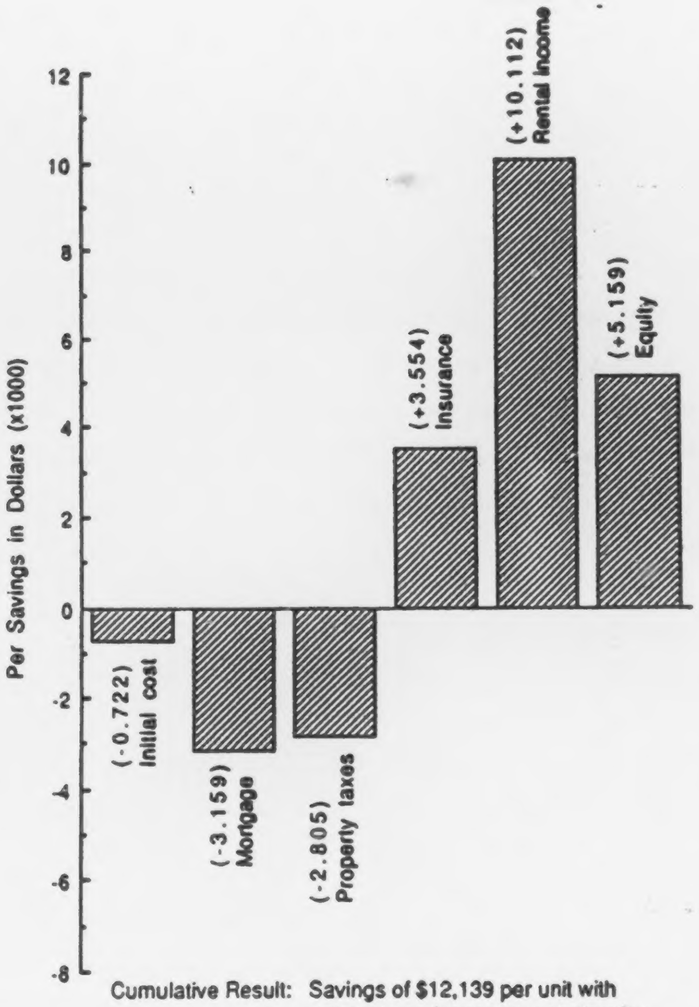
$P_{\text{insur.}} = +\$\ 3{,}554$

$P_{\text{income}} = +\$\ 10{,}112$

$P_{\text{equity}} = +\$\ 5{,}159$

FIGURE 5

PRESENT WORTH SAVINGS FOR CONCRETE AND MASONRY LOW-RISE MULTIFAMILY CONSTRUCTION COMPARED TO WOOD-FRAME, OVER A 30-YEAR BUILDING LIFE.



Cumulative Result: Savings of $12,139 per unit with concrete and masonry construction.

The analysis shows that over the allowable 30-year depreciation period,the owner of the concrete and masonry structure will realize a savings of $12,139 per unit, or $364,170 at today's value of the dollar. In the case of government ownership, where long-term considerations may be more important than immediate cash flow, the type of savings demonstrated above allows for lower rental rates, and lower rent increases. This naturally benefits the tenants.

In the above example, if the rents for each building were initially the same, (difference in $P_{income} = 0$) the present worth savings realized for concrete and masonry would still be $2027 per unit, or $60,810 in today's dollar over the 30-year period. Reduced maintenance costs (not considered in the analysis) would make these savings even greater. This being the case, it makes sense to provide the public with the less expensive, more fire-resistant concrete and masonry structure.

As a supplement to the analysis, here are some other noteworthy, cost-related items:

- The long-term savings gained with concrete and masonry construction could pay for the additional cost of a sprinkler system which would be about $1109 per unit. Logically, this is a much better way to promote sprinklers than through construction trade-offs.

- Materials used in construction for low-rise multi-family housing have a much greater influence on insurance rates than do sprinklers. If any credit for sprinklers is given at all, it is usually 15% or less, and is applied regardless of building construction. In contrast, the difference between the rate applied to a concrete and masonry structure and that for wood-frame, is on the order of 5.5 to 6 times in magnitude.

- Only concrete and masonry structures are eligible for the rate reductions indicated above. Other two-hour rated construction does not qualify, even with sprinklers present.

Despite the long-term cost advantages already described, concrete and masonry construction is not common in the low-rise multi-family market. One likely reason is that low-rise wood-frame construction can currently meet minimum fire safety code requirements at a lower initial cost. As seen in Figure 2, however, lower initial cost does not always reveal the whole picture. Extra money spent on concrete and masonry is well spent, as it enhances the fire resistance of the structure. Yet, if more fire-resistive housing is to be built, financial incentives of some kind will probably be required.

In consideration of privately owned buildings, as well as those that are government owned, the one cost element having the most adverse effect on a concrete and masonry building's positive cash flow is the mortgage payment.

Comparing mortgage payments of the two buildings, the one for the concrete and masonry structure is obviously higher because a larger loan is needed to cover the initial difference in construction costs. One incentive for getting more concrete and masonry low-rise built is to extend the amortization period to 35 or 40 years, thereby reducing mortgage payments. This seems justified, since the durability of concrete and masonry give these structures a longer life expectancy, as acknowledged by the physical depreciation tables in Marshall & Swift's Valuation Quarterly. Other alternatives to extending the amortization period are: lower mortgage rates; reduce payment of loan points; extend the term on balloon payments; or offer higher allowable monthly payments (as a percentage of the buyer's gross income).

The last recommendation is conceptually similar to a precedent established for FannieMae secured mortgages on new and existing energy efficient housing.[28] This procedure, currently in effect, allows lenders to qualify borrowers for larger mortgage payments if the dwelling that secures the mortgage is considered energy efficient. For new and existing homes, appraisers arrive at a thermal efficiency grade through the use of a checklist in the Energy Addendum-Residential Appraisal Report (FHLMC Form 70A) as justification for allowing borrowers higher mortgages. In a second procedure, for new construction only, buildings are accepted as being energy-efficient if they comply with the National Association of Home Builder's NAHB Thermal Performance Guidelines.

Similarly, special underwriting considerations could be given to prospective buyers of concrete and masonry constructed low-rise buildings that meet specified fire-resistance requirements above and beyond those in the model building codes. The risk of owners defaulting on these loans is lessened because of the long-term savings they will acquire with time.

Implementing any of these actions could stimulate the growth of concrete and masonry constructed low-rise in the case of developer-owned properties, and eventually lead to a greater supply for other investors as well. Occupants not only benefit from safer housing, but possible lower rent increases over time, due to future savings that the owner will realize.

Limiting fire damage through structural fire resistance also has a positive impact on the community as well. For example: (1) Concrete and masonry construction adds a stabilizing factor to a neighborhood by reducing the number of burned out buildings that remain boarded up for extended periods of time; (2) Fewer occupants are forced into relocating or having to replace personal property that was damaged in fires originating in other areas of the building. The more units that remain occupied, the greater the incentive and availability of income to implement repairs; (3) Fewer fires with extensive damage also reduce the amount of lost tax revenues due to fire.

Recommendations have been submitted with respect to government- and privately-owned low-rise multi-family buildings in an effort to stimulate the construction of more fire resistant housing for the rental community. Low-rise, multi-family housing constructed of concrete and masonry has much to offer both owner, occupant, and community, but based on the "initial cost mentality", some help is needed in getting this movement started. Incentives offered through federal programs can provide the necessary impetus in establishing quality fire-safe construction for our country's future generations.

5.0 GENERAL COMMENTS AND RECOMMENDATIONS

The greatest number of civilian fatalities from structure fires (over 95 percent) occurs in residential occupancies, mostly in one- and two-family dwellings and in multi-family buildings where some 4,800 people die each year. In a seven year period from 1980 through 1986, residential occupancies were exposed to an average of 662,000 fires per year and suffered property damages averaging nearly $3.8 billion annually.

Deaths and property destruction due to fire in residential structures have been a chronic problem nationwide for decades. While some improvements in the situation have been made in recent years, the statistical numbers still remain so high that in the interest and general welfare of the nation they must be deemed to be unacceptable. Greater federal involvement and support is needed to provide assistance in substantially reducing fire losses.

Some of the specific concerns associated with the national fire problem are addressed briefly in the body of this report. It is not intended to be an all-encompassing review of the total fire problem confronting the nation, but is meant only to give the reader a sense of the problem by addressing some of the technical concerns as well as economic aspects of fire protection and trends in the area.

Part of the report addresses the probability of fire occurring in terms of national statistics; the potential for harm in terms of severity, smoke production and toxicity; and the exposure factors that relate to multi-family housing fires.

One of the problems facing the fire protection community today is the fire integrity of materials and systems of building construction. Construction assemblies such as floors, walls, ceilings, structural framings, and so on, are tested (ASTM E119, Fire Test) and given fire ratings, usually designated as 1, 2, 3, or 4 hour ratings or fractions thereof. Building codes use these ratings to establish requirements for the several categories of fire resistant construction. However, the test method in use today was developed around 1917. Today's technology shows that the severity of an actual fire is dependent on conditions such as the amount and thermal properties of the combustible contents and materials used in the construction, the area and configuration of the compartment, and the ventilation characteristics.

The standard ASTM E119 fire test method does not take such factors into consideration and indeed, under specific conditions, the severity of an actual fire may well exceed the test's time-temperature limits. Putting it simply, there is no assurance that a one-hour fire rated partition, for example, will necessarily serve as a fire barrier for a full hour in a real fire situation.

And yet, the fire resistance requirements in building codes were basically developed on such an assumption.

The indication based on the current state of fire technology is that the standard fire test method should be revised to more closely reflect actual fire conditions. This outlook has, from time to time, been advocated over a period of many years. However, from an economic standpoint, the construction product manufacturers of the nation have resisted such a change because they are understandably unwilling to spend the millions of dollars required to retest materials and assemblies already tested over the past several decades. Further, in many borderline cases, the current fire ratings could be downgraded, possibly causing immense problems within the construction community. Without question, fire severity is an important and complex subject that needs to be addressed so that adequate fire protection can be provided to all classes of building occupancy. Technical solutions other than tampering with the ASTM E119 standard fire test method need to be developed and implemented.

The subject of toxicity from smoke production is a relatively new consideration in dealing with the life safety aspects of fire protection. The inhalation of the products of combustion is estimated to account for about 50 percent of all fire related deaths.

Because of the use of many synthetic materials in the construction of buildings and also because of their use in the manufacture of furnishings and other accessories, the quantity of combustible contents in residential construction as increased dramatically in the last 20 years, causing an increase in the number of fire fatalities due to toxic poisoning. The problem is amplified because most synthetic materials burn at higher heat release rates as compared to such combustible materials as wood and tend to increase fire severity, thus adding to the concerns on property protection.

Considerable research is currently being conducted to identify the toxic products of combustion and their effects on people. Smoke control by mechanical systems as well as by compartmentation need to be more thoroughly examined and mandated through regulatory provisions in building codes. The main problem in this regard is that a standard by toxicity can be adequately measured and limits set for enforcement through building codes has not yet been established. This is a very complex subject that requires time and vast amounts of research to come to practical conclusions. The new synthetics not only affect life safety but also fire severity and its effects on the destruction of property.

The report also deals with exposure factors in multi-family residence fires, especially those factors that involve the types of human disabilities and age groups most susceptible to becoming fire fatalities. It also deals with the exposure factors in structure fires that can pose a threat to neighboring buildings due to radiative and convective heating as well as by flying brands. This source of fire ignition is currently addressed in model building codes, but the subject needs to be further researched and handled in conjunction with the balanced design concept.

Other information is given in the report with respect to the affordability of multi-family housing using noncombustible materials such as concrete and masonry. Costs are compared with the combustible types of construction commonly employed to build multi-family housing units. Comparisons include life-cycle costing as well as insurance and mortgage costs. The focus is on providing fire safety by the use of fire-resistive materials.

The most important aspect of this report to Congress pertains to the concept of handling fire protection requirements for building construction by a methodology that would balance the regulatory needs for providing life safety through active systems of protection in conjunction with the needs to provide property protection by the use of passive systems of fire protection.

In buildings, active systems of construction relate to the use of automatic sprinklers, smoke removal systems, early warning systems (smoke detectors) and the like, all primarily intended to provide safety to life. Passive systems of fire protection, on the other hand, relate to compartmentation and fire resistive systems of construction, all mainly intended of the saving of property.

There are many fire protection inequities now contained in building codes simply because the development of changes to their regulatory provisions are normally handled as separate proposals and little, if any, attempt is made to comprehensively evaluate how each proposal would affect the overall scheme of fire protection. Even worse than this condition is the fact that code developers have allowed reductions in the fire-resistive qualities of rated construction as well as having downgraded or even eliminated requirements for compartmentation. Such concessions were made solely on the basis of providing economic incentives to encourage the use of sprinkler protection. The usual explanation for such actions has been that an equivalency has been provided by the addition of automatic sprinkler systems to account for the reductions in passive protection. No technical substantiation has ever been provided that equates the functions of active systems of protection with passive systems. In fact, the United States and to a lesser extent, Canada, are the only two industrialized countries that have allowed trade-offs on compartmentation and fire resistance. The other nations simply add sprinklers to their construction requirements without changing code provisions on compartmentation and fire resistance. These countries have had better fire experience records to show for their wisdom.

If the United States is to substantially improve its fire loss record in lives, injuries and the destruction of property, it must eventually do so through further development of the regulatory provisions in building codes. However, in order to facilitate such a program, a methodology must first be developed that would be specifically geared for code development purposes in assessing fire risk in terms of safety to both life and property so as to provide a balanced and cost effective approach to fire protection.

To facilitate the development of a balanced design methodology, it is recommended that Congress:

(1) Instruct the United States Fire Administration (USFA) to adopt and publicly promote the balanced design concept;

(2) As a part of such a program, to request the National Bureau of Standards (NBS) to establish a technical definition of balanced design so that a methodology can be developed;

(3) Instruct the Government Accounting Office (GAO) to conduct a cost/benefit analysis of the balanced design concept and report its findings to the Congress through the U.S. Fire Administration.

It is the opinion of the sponsors of this report that before any full-fledged program is launched to develop the balanced design concept, execution of the three recommended steps cited above are necessary in order to provide an awareness within the fire protection community of the benefits of applying such a methodology, to establish the technical basis for the development of the concept by defining the essential elements of balanced design, and finally, to provide the economic justification for such an understanding.

There is a compelling need for the development of a balanced design methodology to provide the means by which building codes can be revised to render an equitable approach to fire protection in the built environment.

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Mr. **Walgren**. Thank you very much, Mr. Heslip. We appreciate the written submission and oral presentation as well.

What can you tell us about the changes that we've seen apparently in the last ten years or thereabouts as this concept of trading off has been brought into play in codes and the like? Have codes for multi-family dwellings been relaxed on a local level? How has the code system changed in this period?

Mr. **Heslip**. Mr. Chairman, I'd like to ask Mr. Jim Messersmith, one of our technical consultants here, to address that.

Jim, do you mind?

Mr. **Messersmith**. Yes, sir. Model codes over the last ten years have probably not relaxed the requirements for multi-family that much. What you have to do is, you have to go back into history though to trace relaxations or tradeoffs, which I prefer to call them, for sprinkler systems.

For example, most of the model codes, most of the local codes, will allow you, if you sprinkler a building, to increase the allowable area of that building from either 100 to 200 percent, depending upon the height of the building, if you sprinkler the building. This, therefore, allows you to leave out compartmentation that would otherwise be required by incorporating fire walls into that building, so you can make it larger without needing a fire wall.

With respect to local codes, some of the things that's going on in the local D.C. area here, particularly over in Maryland and a couple of the neighboring counties, it's my understanding that both of them, the two neighboring counties, P.G. and Montgomery County, have adopted multi-family residential sprinkler ordinances, and to provide an incentive or in order to pay for that sprinkler system they are allowing the dwelling unit separations which were formerly required to be one-hour fire resistance rated to be reduced to one hour.

So I think these are some of the more important—

Mr. **Walgren**. Let me stop you there. The reduction is from—from what to what?

Mr. **Messersmith**. The reduction is from—they formerly required one-hour fire resistance rating to a one-half-hour fire resistance rating.

Other types of reductions are being promoted locally throughout the country as, again, incentives to either encourage multi-family dwellings to be sprinklered or when the multi-family dwellings are being required to be sprinklered as a way of paying for that sprinkler system.

An example: Codes require—model codes typically require attic space or fire stops or draft stopping. Some jurisdictions are allowing the draft stops to be eliminated in the attic space even though in some cases they are not installing sprinklers in the attic space. So these are some examples of tradeoffs and reductions in fire resistance and compartmentation that we've seen over the last decade.

Mr. **Walgren**. And certainly the motives, Mr. Heslip, you mentioned that they were emphasizing life safety at the expense of property. Is that the direction that the sprinklers take? Of course, sprinklers also would protect property as well to the degree that they stop the fire. Are there other examples of the protection of life at the expense of property?

Mr. **Heslip**. Mr. Chairman, I believe that earlier we stated that there seems to be this naive aura within our population that believes that the codes will protect us and the losses are covered by the insurance company, so we don't really have to worry about this issue of property damage, and that is lulling us into this strong desire to reduce the loss of life, which is noble, and completely look away from the issue of reducing loss of—property damage losses.

It is not uncommon today in local code hearings to hear that position stated that today the codes must be concerned about the reduction of lives, we do not consider property losses, and that is a very alarming condition to hear, and that is commonly stated at the codes hearings, and so therefore we believe we must refocus our attention on this issue.

Mr. **Walgren**. In the development of these codes, what forces operate that determine the outcome and decide these issues? I mean we're all for protection of property and protection of life safety, but when we have these local based codes certainly there have to be emphases that respond to very direct interests, I gather.

Mr. **Heslip**. That's right, Mr. Chairman. I believe if we examine the anatomy, if you might, of the codes process, it is a consensus process, it is essentially—the codes are essentially produced by building officials who vote on these issues. They are aware of the political realities of those communities in which they function.

There is a constant pressure to maintain affordability in housing, and that's noble. However, we obviously take that position of not affordability at the cost of lives and property loss. But the driving force from some very well organized interests, private interests, seems to suggest, okay, we'll consider reduction of lives devices, but we've got to get these costs down so we've got to trade off something else.

So I submit there are strong, independent local forces within the communities that suggest, if we're going to give you this, then we're going to take something else out, and that is a reality in the communities across the country.

Mr. **Walgren**. I'm always struck by how light a hand the Government has in these areas, certainly the Federal Government, and when you look at the—even the development of the national codes, essentially it's happening out there in the community that has very specific interests in it, and when it's happening by consensus you have to question whether something would be the right result if it were to the advantage of any one interest group.

If we were to ask the Fire Administration to define "balanced design," what role would sprinklers or tradeoff of sprinklers play in that? I was interested in the testimony this morning where they indicated that, well, they were willing to give more flexibility and access or whether a fire truck needed to be able to drive right into the back of the building or something like that because they were adding a suppression system. On the other hand, they were distinguishing between that and structural requirements that would impede the progress of the fire. Does that make sense from what your thought of what a balanced design would be?

Mr. **Heslip**. I'd like to ask Mr. Rick Thornberry.

Would you address that question, Rick, concerning the—

Mr. THORNBERRY. I'll try to answer that question, as best as I can understand it.

I think that the issue is one of trying to be able to first quantify what the impact might be of the strategies that we implement. Right now, it's a guessing game. We use our best judgment. We get a pool of experts together, and we try to come to some kind of solution through a consensus process.

Mr. WALGREN. It really is a guessing game at this point, isn't it?

Now we have always tried to develop statistics, but the statistics that I have seen developed are really very basic, like, is the death in a single-family residence? Now that's an important fact to know, but that doesn't really go to whether or not there are less fire deaths in sprinklered only situations versus sprinklered plus, well, strictly fire-walled and separated instances, and our data doesn't go to that, does it, from your understanding?

Mr. THORNBERRY. No. We're very sadly lacking in the data base that needs to be as exact as we can get it to really pinpoint what's really happening out there when we have a fire.

The national data base we have right now is just that, it's a general type data base, as you've indicated, and as a fire protection engineer that practices in this field, I find it very frustrating not being able to get a handle on the real problem, where the true failures are occurring, what are those failures in our systems, and how we can use that information to attack the real issues, and I see that we need a better data base to do that with, and I understand that there is an effort going on but it's on an incident-by-incident type effort with the Bureau of Standards and the model code groups investigating major fires or fire consequence that may have significant impact. But, again, that's—it's not a good, strong, broad-based data system that we need—that's being generated by that approach, and we need the large numbers of statistics that we can get on a national scale to help us assess the problem.

Mr. WALGREN. Have we seen changes in the codes that are financially significant to the builders? When they change a code, and let's say they're asking for sprinklers, is it generally that they come out neutral on the expense so that there's—you get the sprinklers and the costs remain the same, or can the costs really be made significantly less expensive for the construction industry? How significant are the cost changes to the overall price of the unit?

Mr. HESLIP. Jim Hurst, I'd like you to address that, please, for the chairman.

Mr. HURST. Mr. Chairman, I'm not really quite sure that the costs, per se, are addressed during the codes hearings, but we've heard a lot of information thus far that, you know, maybe going to concrete and masonry is far too expensive for proposing, and the balanced design concept may be too expensive to go to, and thus the reason for tradeoffs.

Under our written report that we submitted, we have a case study example that addresses the long-term effects in going to a balanced design concept, and without going through the entire case study I could just summarize a couple of points for you that are addressed.

Basically, there is a misconception that going to concrete and masonry construction or a more fire-resistant structure is overly expensive. There have been studies at the University of Michigan that show that this is not necessarily true. We've taken this data and developed it into the case study and put it in the written report.

The second point that comes out of the study is that the long-term effects of building construction are important and sometimes overshadow just the initial cost effect, and that is one thing that we are suggesting and recommending that Congress look into, just not the initial cost portion of it.

The other thing is that we looked at some of the elements, initial costs. That also includes the installation of a sprinkler system. We looked at mortgage costs, property taxes, insurance costs, the effect of rental income between the two buildings, and also the equity build-up that's involved, and the conclusion from that is that over the long term, which was a 30-year period that we used for the life of the building, going to a balanced design concept is actually less expensive than starting out with a wood frame structure over the period of time.

So it's our recommendation that, you know, to overlook, or not necessarily overlook but don't just only look at the initial costs and more so study the long-term effects of this.

Mr. WALGREN. And, of course, the difficulty is that, who's in a position to do that, and I guess that's where the code bodies have to give a very wise judgment as opposed to a judgment that's influenced by any particular interest, and it's a little hard to see that happening directly, but perhaps we can explore that in other ways.

Have you seen shifts in the building materials used in response to changes in the Federal housing code requirements? Has that impacted your industry in any particular way?

Mr. HESLIP. Mr. Chairman, it has indeed, again, we believe, because of the desire to justify it on a cost basis.

We see the containment provisions either lessened or reduced as other what we call active devices are being incorporated in the design, and because we've already established this morning that it's risky business we really have a problem with that taking place. We are just shooting in the dark, we're gambling on producing fire-safe housing, and we shouldn't do that; we don't have to do that. So we notice a significant decline in the use of containment products, satisfactory containment products, in the construction of multi-family housing today.

Mr. WALGREN. I suppose there are costs on the other side of that. Do you see insurance costs increasing because the original building is built in a way that may be more vulnerable?

Mr. HESLIP. Jim Hurst, take it, please.

Mr. HURST. There's a definite difference in the insurance costs between, say, a concrete and masonry multi-family building and also one that's constructed of wood frame, specifically for low-rise. There's a difference in the base rates, just based on the construction of the insurance costs being five and a half to six times less for the fire-resistive structure versus the wood frame one.

Also, another thing is that the insurance industry does not recognize anything other than concrete or masonry as a fire wall. In other words, if you have a two-hour rated concrete block wall versus a two-hour rated assembly of other construction materials, the way the insurance industry applies their rates is, they will only give this type of discount for the concrete or masonry assembly, and that is—the ISO, which the Insurance Services Office has said that many times, and there is documentation to that effect. So there is a definite difference in insurance premiums for the two building types.

Mr. **Walgren**. Do you have any suggestions on how you would decide what a reasonable level of safety would be? I tend to instinctively respond to Mr. Boehlert's characterization of Federal housing that it should be model housing, and that would perhaps say that we ought to have a greater level of safety in housing that is put in place by the Federal Government. We're all apparently too willing to run risks because we see too many lives being lost. Obviously, the system was willing to run those risks. But how would you tie together the definition of a balanced design, and what level of safety would be reasonable? Do you have any guides on that?

Mr. **Heslip**. I'd like to ask Mr. Bill Koffel to address that, please.

Mr. **Koffel**. Well, traditionally, as I'm sure you're aware, the model building codes have considered themselves minimum requirements, and unfortunately what you consider minimum and what I consider minimum may be completely different levels of protection.

I think what the codes drastically lack or fail to do is give us performance objectives. If we have a building that complies with the model building code, we really don't know what the level of protection that is afforded in that building. We don't know whether the code is designed to prevent fire fatalities in the room of origin or fire fatalities outside the room of origin. We don't know whether the building code is designed to contain the fire to the room of origin, to the dwelling room of origin, to the floor of origin, to the building of origin.

I think one of the things that we would propose is that consideration be given to developing performance objectives, and then some of these issues that have already been discussed this morning, such as alternatives, such as the use of the quantitative tools that the Center for Fire Research is developing, can, in fact, be utilized. As Dr. Snell pointed out, those tools provide the technology, they provide the information. There is a need for someone in the community to take those tools and determine whether the appropriate level of protection is being provided.

There are some efforts currently being undertaken by NFPA and by BOCA that I'm aware of where they are starting to attempt to define what is the intended level of protection of the code, and who are we trying to protect, and what is the extent of property damage that we intend the code to provide. Once we have that, then practicing fire protection engineers can take the tools that the Bureau has developed and utilize those to come up with various systems that will provide that intended level of protection.

Mr. **Walgren**. Have we ever had performance standards in Federal fire codes? Do we have them in the military? I'm wondering, what did the Department of Housing and Urban Development move away from? I guess they called them minimum property standards, didn't they? Were they performance related, to your knowledge?

Mr. KOFFEL. To a degree. The trend in this country, the earlier codes were very specification oriented. They would state that a certain wall had to be of a certain construction material and a certain thickness. They have in the past several years changed to a performance document by which they're saying the wall needs to have a one-hour rating or that it has to be noncombustible or that it may be combustible. What we're proposing is an overall performance objective that states what the intended level of protection is, and then we can take the tools and determine whether one hour is appropriate, two hours is appropriate, combustible, noncombustible construction is appropriate, and, to the best of my knowledge, the Federal Government has not had any standards that stated a specific performance objective.

Mr. WALGREN. And somewhere along the line, the concept of redundancy has to come into this design, and when you say you want to set a performance standard, incorporated in that would be fallback protection, I gather.

Mr. KOFFEL. Yes.

I should probably qualify my last statement. There have been some efforts within the General Services Administration of a goal-oriented approach towards fire protection, and obviously one of the factors that has to be built into that approach is the reliability of the systems that we're putting in, and the efforts that I alluded to within NFPA and BOCA to date have yet to establish—they've said, "Yes, we're intending to provide this protection," but not whether it's 95 percent or 80 percent or whatever the range is that we're really trying to provide it. We're trying to do it in the majority of instances that might occur.

One of the things that does need to be factored into the quantitative tools that we have is the potential failure or the reliability of those systems, and that will then tell us what redundant features need to be provided.

Mr. WALGREN. Well, I guess the more I see of it the more I think I understand some of the things that the original America Burning report wanted research done on, research that has never been done, and I just shake my head when I think of, instinctively, the Congress. We spend money in so many self-defeating ways, obviously, and yet you would instinctively feel that the Congress would have been quick to spend money in fire research given the compelling nature of the loss and the size of the loss, billions of dollars of value just totally lost to society, not to mention the lives, and yet we struggle along.

I can't imagine the Center for Fire Research budget is not—what is it now? It is between $6 million and $8 million a year, and that's hardly the level of effort that was envisioned, and then when we see this kind of expression of need for data that could have been developed it's disappointing that we have done so little in the past.

Well, on behalf of the committee, I'd like to thank you for being a resource to us, and we will look forward to talking with you in the future as this issue moves in the Congress. Thank you very much.

Mr. HESLIP. Thank you, Mr. Chairman.

Mr. **Walgren**. And the last witness today, David Brackett, the vice president of the Gypsum Association.

Mr. Brackett, we're pleased you're here, and please come forward, and, as I said before, you written statement will be reproduced in the record of this hearing, without more, and you can feel free to focus on points that you'd like to underscore so that when people use these records their attention will go right to the points you'd really like to make. So please proceed.

STATEMENT OF DAVID BRACKETT, VICE PRESIDENT, GYPSUM ASSOCIATION, SILVER SPRING, MARYLAND

Mr. **Brackett**. Thank you, Mr. Chairman. It's a pleasure and an honor to be here, particularly with the distinguished panels that have preceded me. As a matter of fact, in essence, I could say, "Me too." Most of what you have heard this morning I would agree with wholeheartedly. I think I see three panels that would take the same course. We're talking about using different words to describe the same situations, the same problems, and aiming toward what I think is the same solution but offering a little different way to get there. One may be taking a bus and the other a train.

There are a couple of areas that have not been touched on which I would like to mention. First of all, if I may make a suggestion, it would have been a great benefit to you and your staff if your staff or yourself could have heard the testimony that was given yesterday or the day before in Birmingham, Alabama, at the Southern Building Code Congress meeting when they addressed this issue. You've heard the results. The Congress took a positive step; the recommendations by the Code Changes Committee is to support the sprinklers in multi-family residential occupancies.

But to hear the discussion on both sides and to hear who the proponents were and who spoke perhaps not in opposition to this but expressing reservations for what was expressed earlier—I think Mr. Boehlert mentioned it—as a simplistic solution to what is a very complicated problem, by simply going out and saying you can solve these problems by sprinkling buildings—and I think you have indicated that in some of your statements—is not a reality. There are a lot of factors that need to be investigated.

A case in point might be the recent Supreme Court decision in the State of New Jersey where a community who had directed sprinklers to be installed was found to be liable for the water source, the water supply. The State of Florida, as I recall the testimony—and the gentleman who just left could correct me if I'm wrong—requires no more than 20 pounds of water pressure in the street. That is not sufficient for anything over three storeys in height in order to adequately supply sprinkler systems. So the community has to be involved in this in its environment, where its located, what other impacts are involved in the protection of these dwelling units.

There is the aspect of tradeoffs. This has been a concern to you, it's a concern to us. We have practiced and preached a balanced, if you—balanced protection—that's our term—since the early 1970's. We've produced films in this area, a lot of literature, and have been promoting it.

The thing that we have lacked and I think the thing that all of the testifiers here today have lacked is sitting down and actually qualifying and quantifying what those elements actually are. We don't have the finances; I don't think the masonry people do; PCA doesn't; NBS doesn't, and the Fire Administration doesn't; but maybe if we all get together, we can come to some of these conclusions, and this was my recommendation in my written testimony, that a group be brought together, and again it's my suggestion, under NIBS, the National Institute of Building Sciences, which again is an arm of the Government, the Federal Government, to bring together the necessary expertise to sit around a table and pound out the data that is needed with some—with one element that hasn't been mentioned, and I mentioned it in my written report, and that is the sociologist.

I had the opportunity in early 1970 to spend 30 days at the Bureau of Standards working on lead-based paint and the hazard to the children occupants of housing where lead-based paint was a very serious health problem, injury. We had, oh, perhaps 18 or 20 people representing different disciplines, and I think the individuals that had the greatest input in the outcome of that—and it was for HUD—were the sociologists who put the human aspect back into it.

You can build buildings, as they do in Russia, out of solid concrete, and I suggest that you can't—and this is no discredit to the concrete, but our civilization is not comfortable in that kind of an environment. Very few people like to live in the basements of their homes. They want windows, they want comfort, they want soft easy chairs, so that aspect, to me, is an important one to include if and when such a group could be brought together to try and find the real road that we should be traveling on.

I don't think I would care to make any further remarks, unless you have some specific questions, sir.

[The prepared statement of Mr. Brackett follows:]

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July 22, 1988

Chairman Doug Walgren
Committee on Science, Research and Technology
U.S. House of Representatives
2321 Rayburn H.O.B.
Washington, D.C. 20515

Dear Chairman Walgren:

The Gypsum Association very much appreciates the opportunity to appear before the Committee on Science & Technology to address the issue of fire safety in multi-family dwellings. Fire safety of all buildings and of all occupancies has been a continuing concern to our industry since its inception. Doing our part to reduce life and property losses due to fire is our long standing goal.

The Gypsum Association is made up of all twelve producers of gypsum building materials in the United States and all but one of the Canadian producers. We are a nonprofit group acting as an extension of our membership in all appropriate areas. These areas include working with building codes, doing technical research and testing, dealing with common mining problems and opportunities, and assisting in improved safety and health of the industry's employees. We are also committed to educating contractors who install our products and systems, design professionals who specify gypsum building materials, and the building inspection departments which administer their building codes.

Gypsum, or hydrous calcium sulfate - $CaS0_4$ $2H_20$ as chemists know it, is a very common mineral containing encapsulated water. Converting gypsum rock into building materials is a relatively simple process. Gypsum ore is mined, crushed and ground, then "cooked" to drive off the chemically combined water. At this stage it is known as plaster of Paris. To return the powder to its rock-like hardness, water is reintroduced. In the case of gypsum plasters, water is added on the job site. In our factories, water and other additives are combined just before the slurry is loaded between two continuous rolls of paper to produce one of our many fire resistant board products.

In addition to the naturally occurring gypsum rock used to manufacture over 20 billion square feet of gypsum board products each year, our industry is working very hard to find suitable methods for utilizing a waste material created when (coal) stack gases are scrubbed to remove possible air-borne contaminates. This by-product is a synthetic gypsum and under certain conditions can be be used in place of natural gypsum.

Gypsum products are fire resistant and are classed as non-combustible by all model codes including the former HUD MPS documents. The unique feature of gypsum as a non-combustible fire resistant building material is its "built-in fire sprinkler system". When gypsum board is subjected to fire and its high temperatures, the chemically combined water is driven off as steam providing insulation against heat and flames.

Different gypsum board core formulations result in different time periods of fire resistance. The type X (special fire-resistant) core (boards) designate products that, when tested in accordance with the requirements of Methods ASTM E-119, will provide certain time periods of fire resistance. Our "regular" core products are also fire resistant, and are usually used as wall and ceiling finishes where fire ratings are not required such as interior partitions.

It appears to be difficult for most building code organizations to assess the best way to require the necessary amount of fire protection for the least amount of money. In an effort to improve code requirements for new construction, recent code changes have resulted in allowances for greater floor area, building height, distance to exits, and various other items when automatic sprinkler systems are to be installed. The results of these trade-offs will not be seen for a number of years because very few non-arson fires occur in newly constructed, code conforming, occupied buildings.

It is and continues to be our contention that, if the fire loss record was poor under the old code requirements, substituting mechanical systems for built-in passive systems is, at best, a very dangerous move. Where necessary, sprinkler systems should be added to the built-in fire resistance without any reduction in the required hourly ratings. It is encouraging to note that the code bodies are now coming to the realization that too much of the total fire protection package may have been given away in the effort to get proper sprinkler systems installed in new buildings. A number of recent proposed code changes to the model codes have been rejected on this basis by the building official membership.

Not too long ago, jurisdictions adjacent to the District of Columbia enacted laws requiring the installation of sprinklers in townhouse and low-rise multi-family construction. As a means to off-set the cost of the sprinkler installation, a number of trade-offs are permitted. One trade-off allows the requirement for a one-hour fire separation wall between the units to be reduced to one-half hour. A brief examination of this trade-off will show some interesting results.

Using the example of adjacent "townhouses" divided by a common wall 30 feet long and extending two stories high, results in 480 square feet of wall area common to both units. Covering this wall with one layer of 5/8" thick type X gypsum wallboard, properly installed on each side of 2 x 4 studs, would qualify this construction as a one hour fire resistive wall. The recent code change allows the one hour requirement to be reduced to one half hour fire resistant construction. If it may be assumed that 1/2" thick regular core gypsum wall board will be allowed to be substituted for the 5/8" type X product, the cost difference based on round figures is approximately 7 cents per square foot or a total of .07 times 960 square feet or $67.20. The cost of installation would remain the same.

Since this is a common wall, the cost needs to be divided in half to $38.60 per unit. This "savings" will not go very far in off-setting the cost of installing the sprinkler system. Going one step further, the substitution that has been allowed has no basis in fact. There are no fire tests to verify that 1/2" thick regular core gypsum wallboard would meet the one half hour requirement. If the listed and labeled extra fire resistant core 1/2" type X gypsum board were used, there would be the assurance of a forty-five minute fire resistance rating and there would be an added cost over the 1/2" regular core board of .055 cents per square foot or about $25.40 per unit cost to protect one neighbor from another in the event the sprinkler did not operate and extinguish the fire!

Pro-rating $25.40 over a 30 year mortgage would amount to less than two dollars per year. This is a very small price to pay for the built-in fire resistance which will not leak, get turned off, fail due to a lack of water supply; that will give time to escape as well as provide protection from fire, smoke and water damage from the burning next door unit.

Turning to some general issues, locations where loss of life due to fire are most likely to be found are rural areas first and tenement/slum areas second. We presume that the majority of the units were built more than twenty years ago. Drug abuse is seen to be a major contributing factor. Fire deaths in rural areas appear to be due mainly to lack of modern conveniences such as city water, prompt rural fire service response and non-conforming heating units. In tenements, drug abuse, lack of heat causing illegal installation of various heating devises, along with overloaded electrical circuits appear to be leading causes for this statistical group.

It has been suggested that sprinkler systems be retrofitted into existing housing units that appear to be at risk. When one has neither hot water, gas or fuel to cook with and little to eat, a sprinkler system is not going to be high on the priority list. Forcing landlords to maintain their buildings is one avenue to explore but history tells us that this is almost an impossible task. Some good news indicates that voluntary changes being introduced into the interior furnishing market will eventually add to the reduction of the severity of fires in all buildings as the new fire retardant chairs, sofas and the like reach these areas.

There are several approaches to the cost/risk/benefit factor in determining what safety from fire can be found in any given building. Room modeling, fire load calculations as well as the building layout and construction itself can be dealt with academically today. Using these tools to reevaluate older buildings may be more difficult than dealing with new construction and new interior furnishings. A building can be evaluated, but let thirty, forty or fifty years go by with the deterioration accompanying lost revenue due to low income occupants, and you may find a disaster waiting to happen; no water, no heat, no air conditioning, no refrigeration, no lights, no fire safety.

Research can tell us that if we build according to today's codes with today's materials, fire loss should be greatly reduced. Research can tell us how normal people react to a fire situation. Research does not tell us why fire fighters feel that they must rush into a burning building to fight a fire which could easily take their lives when only property is at stake. The research data being gathered by the State of New York on the toxicity of burning building components will give the user an indication of the possible amount and type of hazardous products being given off after the contents of a room have been consumed by a fire.

Building codes control the construction of new buildings for the health, (fire and structural) safety and welfare of the occupants and remodeling of older structures where major work is to be done. Fire codes control the fire safety of occupied buildings and are usually administered by the fire services. As a rule, neither department is funded to the level needed to assure fire safe communities. City, county, state and federal priorities are usually not geared to deal with fire safety unless and until a disaster occurs.

Building departments are often understaffed or are staffed with untrained personnel. The same holds true for fire departments. Imagine how much time, money, and expert manpower it would take to audit the District of Columbia for the fire safety of just multi-family dwellings and to continue the audit to be sure that the necessary fire safety requirements were carried out. It could be assumed that Mayor Barry would not place this effort very high on his long list of items which need attention nor could he get the funding necessary for this labor intensive project, however well intended. And this will hold true for most cities throughout the United States.

To show that necessary inspections can be conducted where needed and there is a strong enough committment, the country of Australia requires that every building equipped with a sprinkler system be checked by fire inspectors EVERY TWO WEEKS. And they do not permit the trade-offs found in our codes today. Needless to say, their fire loss record is very low.

Except where trade-offs are permitted, current building and fire codes appear to adequately deal with fire loading as it relates to built-in fire resistance and these loads can be addressed by sprinkler system design. Toxicity is being dealt with by the private sector through the National Institute of Building Sciences. The combustibility or fire resistance of building elements need review in light of current code trade-offs. New sections of the building codes are aimed directly at "care housing". The validity of these new "I" Institutional classification requirements will probably be determined by experience as the support for the lower fire resistive requirements are based on human response under fire conditions rather than history or technical data.

Looking for possible solutions, is is our opinion that current building codes for multi-family dwellings should be reviewed by a panel of objective experts to try and evaluate the fire cost/risk/benefit picture. Such a review and evaluation may be the only way to determine just how to balance the protection or balance the design for fire safety.

To be specific, the Gypsum Association recommends that the panel be headed by Dr. John Bryan of the University of Maryland; that the body be made up of two representatives from the National Bureau of Standards, Center for Fire Research and two from the Center for Building Technology; the National Fire Protection Association; at least four building code officials and four fire service members with one each from a large city, a medium sized city, a small town and a rural community; involved building materials associations such as masonry/concrete, steel, wood and gypsum; insurance industry representatives; Federal Emergency Management Administration; and the Department of Housing and Urban Development. We would also suggest that the National Bureau of Standards provide experts in the social aspects of Federal housing. The Council of American Building Officials should be requested to prepare a detailed side-by-side layout of all current code requirements from the model codes impacting fire safety for multi-family housing for use by the panel. Further, we suggest that the panel be convened for up to one week in order to have a uninterupted session where all of the complex issues can be hammered out. The session should be funded by the Federal Government through the National Institute of Building Sciences.

The goal of such a panel should be to determine the best possible balance for protection against fire in multi-family housing as subsidized by the Federal Government. This panel should be expected to evaluate the best available technology dealing with fire science and past and current code requirements, and produce recommendations for how prevent or minimize ignitions, to alert occupants, contain, and extinguish unwanted fire in multi-family housing.

In closing, please be aware that according to a recent Nation Bureau of Standards report, all lives at risk in building fire situations should not be expected to be saved regardless of written requirements. All efforts, of course, should be aimed at the lowest possible number of lives lost and the least possible property loss.

Thank you again for this opportunity to express our views on this most important issue.

Sincerely,

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With over 25 years in the gypsum industry, Mr. Brackett has an expert technical knowledge of the gypsum industry, its products and their uses. He is intimately familiar with federal agencies, departments and bureaus. His previous duties involved working closely with the various model codes, major city and state codes. Currently, he is a member of ASTM Committees E-5, E-6, E-33 and F-16. He is the Secretary for ASTM C-11 on Gypsum and Related Building Materials and Systems. He is an active member of NFiPA Committees on Building Construction, Fire Tests, 101 Fire Protection Features and the Mining Facilities Committee. He is a third term member of the NIBS Codes and Standards Division Management Board, the Tile Council of America Action Council. During his initial stay in the Washington area, Mr. Brackett worked at the National Bureau of Standards where he co-authored a NBS publication, NBSIR 73-139, "A Preliminary Investigation of the Effects of Humidity in the Ignition, Heat Release and Smoke Density Effects for Typical Room Furnishing Materials." This paper became the basis for a continuing Gypsum Association Research Associate program with the Bureau of Standards. Mr. Brackett will now be concentrating on liaison between various government agencies, bureaus and departments and legislative matters for the association. He has headed the Washington office for more than 10 years.

Mr. **Walgren**. Well, thank you for that.

How would you address this reasonable level of safety? I guess what I'm fishing for is that the argument is made that sprinklers—I'm thinking particularly of sprinklers, although the area goes beyond that in the construction tradeoffs, as I understand it. But thinking particularly of sprinklers, the argument is made that they really are a layer that should be seen as going on top of all the rest of the safety that we can build into homes, that they are, in a sense, stand-by protection that should not substitute for built-in protection, and instinctively the concept of safety, asking for fail-safe systems and redundancy, would lead you in that direction.

When you address the question of a reasonable level of safety, should sprinklers be set aside and really put in as an overlay on the protection that we can build in underneath?

Mr. **Brackett**. Given the proven risk, yes.

Mr. **Walgren**. And how do you mean that?

Mr. **Brackett**. The suggestion is that in high-rise business buildings fire deaths are minuscule. Therefore, to require many millions of dollars to be put into high-rise buildings may not be cost-effective. So you have a cost, you have a risk, then you have a benefit.

You can't, again, simply say everything should be sprinkled, and in order to do that—and to come to your point—to trade off is not a wise move. If we have a level of problem, which is obvious, 6,000 or whatever it is in fire deaths, by approaching it from replacing one element with another of equal value will not add to the reduction of those losses.

The sprinkler systems being added to the current construction requirements should and will provide reductions in life loss. How much is going to be a good question, and again I go back to the sociologists. We're somewhat impersonal about it. To sit here and tell you that if you subsidized as the Federal Government or privately—it doesn't matter—just for an example, a three-storey apartment building that is equipped with sprinklers and, for whatever reason, that building turns to private hands, it becomes run down, deteriorated, I don't think anyone would sit here and tell you in 30 years that sprinkler system is going to work.

I pointed out in my testimony that Australia has a remarkable safety record. Their buildings are mandated to be sprinklered, but they do something that we have not seen fit to do, and, again, this was touched on; Mr. Bragdon touched on it. They require those sprinkler systems to be tested not every year or every six months or every month but every two weeks. Those systems must be tested at great cost to have the personnel, the expertise of that personnel, to go around and test every one of those systems. Even an apartment building that's 30, 40, 50 years old may have hot water, may not, may have electricity, may not, may have heat, may not; sprinklers are not going to be very high on the list as far as the maintenance activity is concerned. So to say we can put our eggs in that basket is going to be a very long risk. So, again, the combination, the belt and suspenders, if you overload your trousers to where your belt won't hold your pants up, you need suspenders too.

Mr. **Walgren**. Well, we're all tempted to reach at simple solutions, and the advent of sprinklers has certainly been very attractive, and I would like to see them pursued. At the same time, the question of how safe is safe and what risk people are willing to run—and I suppose that, too, is related to costs.

It's our understanding on this committee, for example, with hotels, that we're really not talking about more than is often invested in new carpeting, literally, for commercial hotels, which they often do simply to attract new customers on the basis of the decor, and it seems wrong that a basic safety system would not be put in a hotel before new decoration would be put in a hotel, and so I guess the less the cost, the more willing people would be to see the sprinkler system as an overlay on the basic fire protection systems that could be built permanently into a building. I hope that would ultimately come into play.

You indicated—turning to the Institute on Building Sciences as an entity to look at what a balanced design should be, how would they differ from the present model code groups? Are we really turning to them because they would be new? I guess they would be not as involved with the interest groups that have at least had a part in fashioning the present codes.

Mr. **Brackett**. Well, the model code groups are organized for an entirely different purpose. They're concerned with fire, although the fire portions of codes make up about a third of it. They are also concerned with all kinds of other elements. NIBS has the ability to bring together expertise from around the country at Government levels, at academia levels, manufacturers, concerned individuals, which the model codes wouldn't be doing.

I think the model codes certainly need to be a part of it, and I think they need to explain what—and this was suggested by the last panel—what they are actually offering as far as protection: What does their code actually say? What do these three model codes really say that we have when they say, "We have protected multi-family dwellings"? I need to hear that from them, and I need to hear from Jack Snell's organization as to what research is lacking from the input here.

The fire service people have a major stake in this. They have been reduced to, gosh, in some cases, just a token service any more. They simply are not funded. They can't have the equipment, the support. It's showing up as a very sad area which is going to lead to some more certainly property loss if not life loss too. I simply thought that they—since they are the National Institute of Building Sciences, it might be a proper place to put it.

Mr. **Walgren**. What role should the Federal Government play in determining fire safety in multi-family structures? Are you comfortable with the Federal agencies settling on a code or a standard and requiring that in those areas that they reach?

Mr. **Brackett**. When they follow the model codes, yes.

Mr. **Walgren**. Do you feel they should follow the model codes so ultimately we should be grounded in the code process as you now see it?

Mr. **Brackett**. Well, that's where the mandate comes from, that's where the enforcement comes from, and that's where follow-up through the fire codes, not building codes but fire—the follow-up comes through the fire code, which is usually implemented by the fire services for existing buildings. Your building code can build you a fire-safe building.

Again, if you go through the most recent Fire Journal, there are several tables on U.S. residential fire deaths, 1987, and if you look at the causes, it's not the buildings in most cases. If it is the building, it's because the building wasn't built properly or maintained properly. It was the people, and, again, this was mentioned earlier. That's why I said, "Me, too," when I sat down.

The fact that someone has altered something in the building after it was built, this needs the Fire Service follow-up, which they can't afford to do today. They can't go around to see that fire doors are not blocked open and that sprinklers have not been turned off, or, if they have been turn off for repairs, that are put back into service promptly the way they should—that sort of thing. That is where I think the Federal Government certainly should lead the way as far as funding is concerned. I'm kind of a local fellow, I'd rather see that come at the local level, but perhaps through the encouragement at the Federal level and with some consideration for tax relief, where these steps are being taken, until they are implemented, at which time, then things could balance themselves out.

Mr. **WALGREN**. But even though it is the human beings that may create the risk, the question is, what do we assume the protections are that may be built in?

Mr. **BRACKETT**. I would suggest that some 40 percent of the fire deaths are either drug- or alcohol-related. I would suggest that no matter how much money you poured into this, that you're not going to save those people. Other people might argue with me and say that sprinklers are going to save everybody or smoke detectors are, and I don't think that that has a basis in fact. You can't wake up someone that is inhibited with a buzzer. It is not the flames that kill them, it's the smoke.

We are working very diligently and, again, mentioned earlier, in the furnishings area to reduce the combustibility and the toxicity of those components. Building materials—again, by the time they are involved in a fire, the occupants are either out or dead; there isn't much choice.

So if you reduce that percentage, if you take that percentage of 40 percent of the number of death losses and say—and that's undoubtedly too high—and set it aside and say, "Well, we can't help those people," or pick a percentage—10 percent; they simply are going to commit suicide—then you have a number that you're working at. Then you've got to evaluate it on the basis of how much money can we pour in to keep them from dying in fire? How much money can the Federal Government put into the transportation system to keep 65,000 people from dying? Where is your priorities—where are your priorities? It is a very complex problem; there's no question about it. I think the United States is lacking in a good fire safety record due to our upbringing. We have paper cups that we can throw away. We waste things.

I was reading something that really isn't relevant on one hand, but yet it goes back to something that was brought up earlier. Why do the Japanese have a fire record? The Japanese driver and highway policy: The Japanese have reduced their highway deaths by 450 percent in 10 years. It costs $1,000 to get a driver's license. You must go to school, and they do it. It's amazing, when you can get the people involved, how much you can save. No matter how well you build the automobile, they're going to kill themselves, as we do here, because you watch a television ad, and they're going 150 miles an hour in 6 seconds. We have not had the education in fire prevention, fire protection; we don't have the concern. I would suggest that there are very few people in this room, with all the concern that we have, that have a sprinkler system in their home, and yet they know that if the emergency arose it would help them, it could save their lives or the lives of their families.

Mr. WALGREN. Or even know that their smoke detectors are, in fact, functioning at that point.

Mr. BRACKETT. In our house, with the way my wife cooks, I know that it's working, because when the dinner is done it goes off.

Mr. WALGREN. Well, all right. Well, I want to express our appreciation on behalf of the committee for your contribution, and we'll look forward to talking to you in the future about the question. With that, we'll close the hearing, and I want to personally say thank you all very much.

Mr. BRACKETT. Thank you, sir.

[Whereupon, at 12:35 p.m., the subcommittee was adjourned.]

APPENDIX

LETTERS AND STATEMENTS FOR THE RECORD

THE CONTAINMENT OF SMOKE AND TOXIC GASSES IN A FIRE EMERGENCY: LIFE-SAFETY CONSIDERATIONS IN THE COMPARTMENTATION STRATEGY

Testimony presented by Robert C. Spargo, A.H.C.,
before the Science, Research and Technology Subcommittee,
Committee on Science and Technology,
Congressman Douglas Walgren, Chairman.

Introduction

Good morning. Speaking on behalf of the Builders Hardware Manufacturers Association, I would like to thank you for the opportunity to submit testimony to you today on the subject of fire safety in multi-tenanted housing construction.

My name is Robert C. Spargo, and I am the vice president of sales and marketing for Rixson-Firemark, of Franklin Park, Ill. Rixson-Firemark is a manufacturer of door hardware and controls.

I have long been active in industry affairs, particularly with regard to model building codes and their relation to fire/life safety concerns. I have served as a member of the Board of Directors of the Door and Hardware Institute and as a member of that organization's Executive and Building Code Committee ... am the past chairman of the Society of Architectural Hardware Consultants and the current chairman of the Public Relations Committee the Builders Hardware Manufacturers Association.

The Door and Hardware Institute and Builders Hardware Manufacturers Association are companion organizations that together represent the manufacturers, distributors, and professional specifiers (Architectural Hardware Consultants), of builders hardware.

The Builders Hardware Manufacturers Association exclusively represents the interests of the manufacturing segment of the architectural hardware industry. Member products include hinges, door closers, locking devices and related hardware, exit devices, other door hardware and trim, and cabinet hardware. Some 80% of the U. S. manufacturers of architectural hardware are represented in the membership.

The Door and Hardware Institute includes within its membership the distributors and specifiers of these and related products.

BHMA staff or members are in attendance at all model building code meetings, providing testimony as necessary to clarify or help formulate criteria for builders hardware products in the life-safety codes. I am here today to bring to your attention some of our concerns on the fire safety issue in multi-tenanted housing.

The Issue Before Us

It is my understanding that this Subcommittee will look at the issue of fire safety as it relates to construction practices and fire code requirements in low rise, multi-tenanted construction. While the primary focus of the testimony will be on residential construction, we understand the scope of inquiry to include fire safety in facilities such as nursing homes, hospitals and other extended care facilities such as housing for the elderly.

Our interest in the subject matter at hand stems from our long involvement on behalf of the hardware industry in the building codes process in defense of the concept of balanced design in all types of multi-tenanted construction, but with particular emphasis on medical and residential care facilities in which residents may be physically incapable of responding to a fire emergency.

I am here to express the deep concern of the Builders Hardware Manufacturers Association with the reduction in overall fire protection now afforded by model building codes as a result of the practice of "trade offs." It is a concern we share with many of the other associations that are presenting testimony here today.

More specifically, I wish to alert the committee to the particular dangers associated with the unchecked spread of smoke and potentially lethal toxic gasses in multi-tenanted housing situations, and to recommend that measures be adopted in future housing-related legislation that would effectively reduce the threat this problem presents.

I have for many years been appearing before such organizations as the Southern Building Code Congress, the National Fire Protection Association, the Army Corps of Engineers, countless regional and local model building code organizations, and all manner of door and hardware groups, to argue on behalf of the concept of balanced design and against the concept of "trade offs."

Trade-offs are regulatory concessions offered to architects and developers as an incentive to install automatic sprinkler systems. Without these concessions, it is argued, sprinkler systems would be too costly for many owners to install.

Let me make clear that we advocate the use of sprinkler systems wherever warranted. However, as carefully engineered as most sprinkler systems are, they are always prone to malfunction, improper installation, inadequate maintenance or deliberate tampering. It is our position, amply supported by other testimony presented today, that such systems should never be allowed to bear the whole burden of fire protection.

Please also note that there is overwhelming evidence that sprinkler systems, although they are generally adequate to protect property when functioning properly, can actually complicate life safety problems under certain circumstances.

We concur emphatically with the Precast Concrete Institute, Portland Cement Association, National Concrete Masonry Association, Brick Institute of America, National Ready Mix Concrete Association, and the Expanded Shale Clay and Slate Institute, that the only safe approach to providing adequate protection in multi-tenanted housing, is a system of balanced design that includes detection, suppression and compartmentation systems.

To trade off any one system for others is to play with the life and safety of all who occupy inadequately protected housing.

This balanced design approach, as indicated in other testimony, mixes both active and passive elements to arrive at a higher level of protection from fire danger than would be available from any single element.

Smoke, Toxic Gasses, and Compartmentation

I would like to focus my remarks on an area of concern that is only touched on in other testimony; the problem of the containment of smoke and toxic gasses in a fire emergency.

Compartmentation is a building strategy that relies on fire-resistive materials to limit the involvement of a fire to the room or compartment where it originates. The materials from which the floors, walls and roof surrounding the compartment are constructed must serve as fire barriers.

Compartmentation through fire-resistive construction is primarily a strategy for fire containment. The life-safety value of the strategy is found in its ability to isolate potential victims in remote locations from flames, while ensuring the structural integrity of the building.

The strategy is incomplete in its life-safety protection, in that it fails, in and of itself, to protect persons in remote locations from the greatest danger posed by a fire emergency: the danger of inhaling lethal doses of the toxic smokes and gasses that are the by-products of fire. While fire-resistive construction will limit the spread of flames, it will not check the extremely rapid spread of smoke and toxic gasses through doors or other openings in the construction assembly.

Death or injury from smoke inhalation is not a small problem. In fact, research conducted over the past several decades has established that between 50 and 60 percent of fire-related deaths are attributable to the inhalation of smoke and toxic gasses generated by the fire.

It has also been established conclusively that life-threatening smoke conditions consistently precede life-threatening temperature conditions in fire emergencies ... and that smoke and gasses spread rapidly from the point of origin and are present in harmful concentrations at great distances from it.

Barrier Doors

The solution to the problem appears simple. Research has proven that, in a properly compartmented structure, smoke and gasses can be effectively contained within the room or area of fire origin by a closed, fire-rated barrier door.

But as with most things in life, the appearance of simplicity is deceptive.

The problem arises in assuring that the barrier door will in fact be closed when the fire emergency occurs.

Even under the best possible circumstances, it is simply too much to assume that a knowledgeable, properly trained individual will be on hand and able to close the barrier door in the critical first minutes of a fire emergency.

Smoke and Toxicity: A Case History

A single, tragic example taken from an Investigation Report published in the January 1987 issue of the FIRE JOURNAL and authored by Michael S. Isner, a Fire Protection Specialist in the National Fire Protection Association's Fire Investigations and Applied Research Division, will illustrate the point.

The Investigation Report concerned a fire that began in a patient's room in the Hospice of Southeastern Michigan, a community facility designed to provide long-term professional care.

The report indicated that the fire occurred in a patient room on the second floor of the West Wing of the facility. The hospice was constructed of fire-resistive materials which successfully contained the fire itself to the room of origin. However, six patients perished during the fire, and two others died from fire-related injuries a few days later. Seven of the fatalities were among patients whose rooms were immediately adjacent to -- or across the hall from -- the room in which the fire originated. The eighth fatality occurred in the room in which the fire began.

The report noted that hospice personnel were fully trained in fire emergency procedures and made an immediate effort to get to the fire area and rescue patients within minutes of the sounding of the alarm. Unfortunately, no attempt was apparently made to close the door to the room of fire origin, though one patient was successfully evacuated from it.

Citing evidence from the scene, the investigator noted that the fire had fully involved the room in less than five minutes, reaching a level of such intensity that it was impossible for staff to fully implement emergency procedures such as properly closing doors and evacuating patients.

"Smoke from the rapidly growing fire was the primary cause of death or injury to the patients," the FIRE JOURNAL reported, adding, "The doors to individual patient rooms notably affected smoke spread in the West Wing (where the fire was located). All of the patients who died in this fire were occupants of rooms where the doors had been left fully or partially open."

The report also noted that "very little smoke seeped into Room 209 (adjacent to the room of fire origin) because the door to this room was closed." The two occupants of this room survived.

This disaster is in many ways a best-case scenario. The fire was discovered quickly and trained emergency staff responded immediately. Yet eight persons died from smoke inhalation, all but one victims of smoke and gasses that reached them through open doors.

I hope my point is obvious. Had the patient room doors closed automatically in the first moments of the emergency, the patients would have had the twin protections of a barrier door between the room of fire origin and the corridor, and another barrier door between their rooms and the corridor. It would have made a difference.

Taking Chance Out of the Barrier Door Strategy: Smoke-Actuated Door Controls

This example, and countless others like it, bring me here today as an advocate for legislatively mandated systems that will ensure that critically necessary barrier doors will be in place when the fire emergency occurs.

One such system, smoke-actuated door controls, is manufactured by members of the architectural hardware industry. This widely available, inexpensive door-control hardware combines the passive, early detection function of a smoke detector with active life-safety protection in the form of automatic door closing functions.

Smoke-actuated door controls balance the need for an open door in normal situations with the need for one that will close automatically in a fire emergency.

The door controls are actually several pieces of equipment linked together in various ways to perform an integrated series of actions that control door motion and make it responsive to fire emergency conditions.

One complete system contains an electromagnetic door holder/release, a door closer and a smoke detector. Each piece can be installed individually and wired to the others, or the system can be incorporated into one housing.

The electromagnet holds the door open in normal operation. When power is cut or the detector senses smoke, the current to the magnet is broken, and the door is free to close. At this point, the surface closer in the unit will handle door motion. The door will latch tightly, but will operate normally.

These door controls directly address the smoke inhalation problem. They complete the containment function begun with fire-resistive construction by assuring that a barrier door will automatically close to contain the smoke and gasses generated by the fire.

Smoke-actuated door controls work. They have been saving lives for decades. They are a recognized life-safety strategy included in all the model building codes.

They have proved to be of particular value in such applications as hospitals, nursing homes and hotels where persons threatened by a fire emergency may not be able to immediately evacuate the building.

Summary and Recommendations

No system of fire protection, short of a balanced design approach that includes elements of detection, suppression and containment, can be considered adequate. Containment strategies based on fire-resistive construction assemblies are essential to effective fire protection and can not be traded off for sprinklers or any other single system or approach.

But fire containment strategies must do more than limit the spread of flames. The problem of protecting residents from the toxic effects of the unchecked spread of smoke and gasses must be considered as one element in the containment function of the balanced design approach.

Smoke-actuated door controls have been proven effective in ensuring that barrier doors will automatically and reliably perform their proper role in containing smokes and gasses, and should be one element in an overall strategy for limiting the impact of a fire through containment.

These are facts that should be kept in mind as the committee deliberates on the kinds of fire protection systems it will mandate in future multi-tenanted housing legislation, particularly where we may find those not fully capable of caring for themselves in a fire emergency. In a very real sense, their lives may be in your hands.

Thank You.

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NFPA

August 15, 1988

ROBERT W. GLOWINSKI
TECHNICAL RESEARCH COUNSEL
202-463-2768

Ms. Carrye Brown
Subcommittee on Science, Research &
Technology
House Committee on Science, Space &
Technology
2319 Rayburn House Office Building
U.S. House of Representatives
Washington, D.C. 20550

Re: Fire Safety in Multi-Family Housing

Dear Ms. Brown:

Thank you for allowing us to submit written comments on the wood industry position on Fire Safety in Multi-Family Housing subsequent to the hearing of July 28, 1988. The National Forest Products Association is the Washington, D.C. based trade association representing the lumber and wood products industry. The products produced by our members are used extensively in residential construction, and as you know much of this construction is multi-family. As such, we have a vital interest in the fire safe performance of this construction type.

The issue of the hearing concentrated on what appears to be a dispute between the masonry and gypsum industries on the benefit of sprinklers in association with various types of construction. Before addressing that point one must first recognize what differences exist between the two types of construction when no sprinklers are present. As you know, Dr. Jack Snell of the National Bureau of Standards responded to a question from Representative Boehlert on the difference between a one-hour masonry wall and a one-hour gypsum wall. Dr. Snell pointed out that in terms of fire performance under present test methods there is no difference between the two. That is, both types of walls are expected to fail at the end of a sixty-minute period. The benefit thus provided by sprinklers would be that of additional fire protection regardless of the type of construction.

During the second panel discussion, Mr. Richard Thornberry, representing the National Concrete Masonry Association (NCMA), stated that the national data base was inadequate to identify construction issues. We take exception to this statement, as the

U.S. Fire Administration maintained NFIRS data base, State of California CFIRS data base, as well as the National Fire Protection Association statistical data base are all able to evaluate fire record data based upon construction type. In fact, the NCMA was a sponsoring organization of a 1978 study at the University of Maryland that attempted to use two of these data bases to claim an advantage of masonry construction in multi-family residential construction fire performance. Subsequently, the U.S. Fire Administration (USFA) sponsored a similar study at the University of Maryland on fire losses in multi-family residences. Not surprisingly, the second Maryland study agreed with the first that a definite relationship existed between type of construction and fire loss. The report was not distributed under the U.S. Fire Administration name and the NTIS distributed copy included a statement that USFA did not necessarily agree with the conclusions reached by the report's authors.

In response to the Maryland study, the National Forest Products Association conducted its own analysis of the available computerized fire record data. When the data was analyzed and no similar relationship was found between fire losses and construction type, the data used in the Maryland study was again reviewed in depth. It then became evident that even the data used by the Maryland study's authors did not support the conclusions reached, and the enclosed Special Report was prepared using the very same data from the University of Maryland study.

As you will read, the fire record data indicated no relationship between construction type and life loss or injury from fires in multi-family occupancies. Perhaps this is why the testimony at the hearing did not refer to any relationship between construction type and casualties. Some reference was made, however, to a relationship between construction type and financial losses in multi-family residential fires. But as you will also read in the report, even this relationship is not fully supported. What is missing, and is critically important in this analysis, is an evaluation of the dollar losses at risk prior to the fire. Simply to say that a masonry building is safer because its average dollar loss per fire is lower than that of buildings with gypsum fire walls ignores the question as to the value of the buildings in which the fires occurred. If the average value of the gypsum-walled buildings was greater to begin with, then actually the loss in the masonry building could be greater, at least as a percentage of original value.

To further comment on the issue raised about fire insurance, I would like to point out that the examples given from Chicago, Illinois are not typical of the rest of the United States. In fact, it is our belief that Illinois insurance laws prohibit

Insurance Services Office (ISO) insurance rate setting and insurance rates are left to insurance company discretion subject to market-place competition. Fire insurance rate quotes received from one company in Illinois may differ greatly from those quoted by another company.

In fact, the National Forest Products Association attempted to compare the effect of insurance rates in those states using ISO guidelines. A copy of the report, "Construction Costs and Fire Insurance" is also enclosed for your review. Without performing extensive economic analyses, it quickly becomes evident in that report that the interest earned on construction cost savings with sprinklered one-hour gypsum protected wood-stud walls more than offsets any higher fire insurance rates. And the cost and benefit of sprinklers is included!

As is probably evident from this letter, the National Forest Products Association does not agree that there is any fire safety benefit provided by masonry multi-family construction. As pointed out by Dr. Snell, in terms of structural fire performance, there is no difference between a one-hour masonry wall and a one-hour gypsum wall. The same would be true of two hour fire walls. Given that the structural fire performance is the same, and the fire record data does not indicate any greater losses in non-masonry construction, what justification can be given for favoring masonry over other construction types? I hope you will recognize, as have the model building codes that have considered these same masonry industry arguments, that no justification exists.

Thank you for the opportunity to comment and provide you with the enclosed materials. If it would be helpful in your deliberations, I would be pleased to meet with you and discuss any of these items further or provide additional detail. In any respect, please notify me when the hearing report is available.

Sincerely,

Robert W. Glowinski

Robert W. Glowinski

RWG:cmm
Enclosures

SPECIAL REPORT
NATIONAL FOREST PRODUCTS ASSOCIATION
1619 Massachusetts Avenue, N. W., Washington, D. C. 20036

CONFIRMED: FIRE LOSSES IN MULTIFAMILY BUILDINGS DO NOT DEPEND ON TYPE OF CONSTRUCTION

SUMMARY

The concrete and masonry industries have issued a report proposing that wood frame construction be excluded from use in multifamily residences with more than 20 living units. The basis for the proposal is a claim that certain fire record data show a relationship between fire losses and type of building construction.

When all available fire record data are considered, no relationship is found to exist between construction type and extent of fire spread, injuries, or fatalities in multifamily residences. The data demonstrate the effectiveness and consistency of present building code provisions for such buildings.

INTRODUCTION—Entire Fire Record Data Picture Shows No Relationship Between Construction Type and Fire Loss

The concrete and masonry industries have issued a "Fire Protection Planning Report" purporting to confirm a relationship between fire losses in multifamily buildings and type of building construction. To support its claims, the report cites an analysis conducted by the University of Maryland on fire record data available from the U.S. Fire Administration (USFA). However, conclusions drawn in the "Fire Protection Planning Report" reflect only a portion of the fire record data available, and are therefore drawn out of context. It is the position of the wood products industry that the relationship claimed between construction type and fire safety is actually nonexistent.

Readers of this analysis are invited to evaluate the entire data picture available, rather than only those portions that the concrete and masonry industries have chosen to present. When all available information is considered, the conclusions drawn are fallacious and the restrictions proposed on wood frame construction by these competing interests are unwarranted.

BACKGROUND—Masonry Industries Fund Fire Record Data Study at University of Maryland

In 1978, the concrete and masonry industries commissioned a study to be conducted by the Department of Civil Engineering, University of Maryland, on Fire Losses in Low-Rise Multifamily Residential Buildings. Sponsors of this study were the Brick Institute of America; Concrete Reinforcing Steel Institute; Expanded Shale, Clay, and Slate Institute; National Concrete/Masonry Association; National Ready Mixed Concrete Association; Portland Cement Association, and the Prestressed Concrete Institute.

Fire record data were obtained from the U.S. Fire Administration for five reporting states. The analysis was made by James Colville, Daniel Walsh, and Donald Vannoy of the Department of Civil Engineering at the University of Maryland. Although the available fire record data could not be broken down into high-rise or low-rise construction, the report's title claimed to analyze "low-rise" residential buildings. This first report concluded that a definite relationship existed between building construction type and fire loss. A final report was released in June, 1979.

U.S. Fire Administration Also Funds Study at Maryland

Subsequently, the U.S. Fire Administration funded a similar study of fire losses in multifamily residences, using fire record data from additional states participating in the Administration's fire incidence reporting system. A grant for the study was awarded to the University of Maryland, Department of Civil Engineering. This second evaluation was conducted by James Colville and Bahram Behnami, at the University.

Almost all the data presented in the concrete and masonry industries' "Fire Protection Planning Report" was taken from the second Maryland study.

Conclusions the Same in Both Studies

As in the first report, the second Maryland report concluded that a definite relationship existed between type of construction and fire loss, and that "serious consideration should be given to prohibiting use of wood frame construction in multifamily residences with more than 20 living units."

All Fire Performance Data Need to be Considered

The foregoing conclusions were based on three measures of fire loss: extent of flame spread, dollar losses, and number of injuries. Additional information on fire performance of multifamily residences, including information on fatalities, should be considered if a full picture of the fire performance of various types of construction is to be obtained. Such additional information, based on U.S. Fire Administration data, is discussed in the following sections.

DATA BASE—Data Base Uses Only Part of Available Fire Incidents

All data used in the University of Maryland study were obtained from the National Fire Incident Reporting System (NFIRS) of the U.S. Fire Administration (USFA) or the California Fire Incident Reporting System (CFIRS). The USFA collects fire incident reports from participating states. Although it is known that errors occur in the coding and recording process, it is assumed for analysis purposes that all data are correct and that applicable building code provisions have been met. Otherwise arbitrary decisions would have to be made as to which data should be eliminated.

Fires Confined to Area of Origin are Excluded

The University of Maryland investigators chose to exclude from their analysis fires that were confined to the area of origin. This exclusion was made on the hypothesis that these fires would not be significantly affected by construction type. However, elimination of such data tends to distort the relative significance of factors influencing fire losses. Of 59,495 total multifamily fire incidents in the data bank analyzed, 35,908 had a known extent of flame damage. Of these, 27,885 were confined to either the object or area of origin (see table A1), resulting in a data base of 8,023 fire incidents in high-rise, mid-rise, and low-rise multifamily buildings for purposes of evaluating the effect of construction type. Analysis of only 13 percent of reported incidents does not provide an adequate basis for determining either the need for or the priority of possible changes in building regulations to affect a reduction in fire losses.

EXTENT OF FLAME DAMAGE—Data Reveal No Consistent Difference in Extent of Flame Damage Between Ordinary and Wood Frame Construction

The "Fire Protection Planning Report" claims that for construction types 5, 6, 7 and 8 (protected ordinary, unprotected ordinary, protected wood frame, and unprotected wood frame) the "relative probability of flames extending beyond [illegible] room of origin and beyond the fire rated compartment of origin increases as the fire resistivity of construction decreases." This claim suggests that ordinary construction consisting of masonry load-bearing walls and wood floors and roofs has a lower relative probability of flame damage than all-wood frame construction. This conclusion is based on analysis of the percentage of fires that first spread beyond the area of origin and them spread beyond the room or fire-rated compartment of origin — their so called "Extended" fires. However, the data available in the University of Maryland study show the following:

Table 1. Percent of "Extended" Fires that Spread Beyond Fire Rated Compartment of Origin (NFIRS-15 states)

Type of Construction	3-6 units	7-20 units	Over 20 units	All units
Fire Resistive	33	32	13	23
Protected Non-Combustible	37	14	20	22
Unprotected Non-Combustible	39	34	22	33
Protected Ordinary	41	41	38	41
Unprotected Ordinary	48	46	50	48
Protected Wood Frame	47	44	45	46
Unprotected Wood Frame	59	50	42	55

Table 2. Percentage of "Extended" Fires that Spread Beyond Room of Origin (NFIRS-15 states)

Type of Construction	3-6 units	7-20 units	Over 20 units	All units
Fire Resistive	46	51	28	39
Protected Non-Combustible	55	38	43	44
Unprotected Non-Combustible	52	53	30	47
Protected Ordinary	56	57	49	54
Unprotected Ordinary	64	61	63	63
Protected Wood Frame	66	60	62	64
Unprotected Wood Frame	71	57	51	65

The data in Tables 1 and 2 do not support the claims in either the University of Maryland or "Fire Protection Planning" reports that there is a consistent relationship between construction type and fire spread, and that flame damage in ordinary construction is less than in wood frame construction. From the data used the authors could just as well have recommended that ordinary construction types also be banned. This is especially true in the area the report recommends regulating: the over-20-units category. The correct "ordering" of construction types for the size-class, in decreasing order of ability to minimize extent of flame damage loss for "Extended" fires spreading beyond either the room or fire rated compartment of origin is:

Type 1	Fire Resistive
Type 4	Unprotected Non-Combustible
Type 3	Protected Non-Combustible
Type 5	Protected Ordinary
Type 8	Unprotected Wood Frame
Type 7	Protected Wood Frame
Type 6	Unprotected Ordinary

It should be noted that Figure 3A of the "Fire Protection Planning Report" shows that for over 20 units, in fires spreading beyond the fire rated compartment of origin, the percentage of "Extended" fires for unprotected ordinary construction is approximately 39%. However, the University of Maryland report shows this number to be 109 incidents out of 216, or 50%.

Similarly, data from California reveals the following:

Table 3. Percentage of "Extended" Fires that Spread Beyond Fire Rated Compartment of Origin (CFIRS)

Type of Construction	3-6 units	7-20 units	Over 20 units	All units
Fire Resistive	5	4	2	4
Non-Combustible	5	8	2	5
Ordinary	3	4	3	3
Wood Frame	18	15	8	14

Table 4. Percentage of "Extended" Fires that Spread Beyond Room of Origin (CFIRS)

Type of Construction	3-6 units	7-20 units	Over 20 units	All units
Fire Resistive	56	38	42	46
Non-Combustible	45	47	54	48
Ordinary	54	57	59	57
Wood Frame	63	62	56	61

While the California (CFIRS) data might appear at first glance to support the masonry industry claim of a difference between ordinary and wood frame construction types, a look at the CFIRS data for the other two construction types (fire resistive and non-combustible), shows the claimed "pattern" is no longer evident. For example, in fires extending beyond the room of origin in over-20-units construction, the percentage of extended fires is as follows:

Fire Resistive	42%
Non-Combustible	54%
Ordinary	59%
Wood Frame	56%

From this information, the masonry industry could just as well have recommended that multifamily residences not be built of ordinary construction either, since the relative probability of loss is greater than that for either non-combustible or wood frame construction.

Data Base Only Small Part of Available Data

It should also be noted that these date are only for those fires that first spread beyond the area of origin. This group represents only 22% of the NFIRS fire incidents.

No Ordering of Construction Type and Flame Spread Evident

Considering all the above data — especially for the building size for which recommendations are made (over 20 units) — the clear "ordering" of construction type claimed by the concrete and masonry industries is not apparent. As part of a further investigation, the National Forest Products Association attempted to determine if smoke detectors, now required in all residential occupancies by the model building codes, had any effect on the extent of flame damage.

Smoke Detectors Have Significant Effect on Reducing Flame Damage in Most Construction Types

The results indicated that where smoke detectors were present and operational, the extent of flame damage was reduced in most types of construction (Tables A2 and A3). This is in addition to the relatively small percentage of fires that spread beyond the area of origin initially.

Although data for all construction types are discussed in this analysis, it should be noted that the authors of the "Fire Protection Planning Report" consider only construction types 5, 6, 7 and 8 (ordinary and wood frame) in their findings. Such confinement was justified on the basis that available fire record data are most extensive for these four construction types. However, data for fire-resistive and non-combustible construction *are* shown in the bar graphs of the report. Why extent of flamespread data for all construction types were not considered in developing the conclusions in the report is not explained.

DOLLAR LOSS—NFIRS and California Data Show Different Relations Between Dollar Losses and Construction Type

Available NFIRS data show an expected increase in dollar losses as the fire resistivity of construction decreases. Moreover, one would expect, as indicated in the report, that total dollar losses increase as the size of the building increases, regardless of the type of construction. It is interesting to note, however, that these expected and observed trends from the NFIRS data do not hold for the CFIRS data.

Again, in the category where regulation is recommended — over 20 units — California data reveal the following average dollar losses, for ordinary and wood frame construction (type 5-6 and 7-8 in NFIRS):

Table 5. 1978 CFIRS — Over 20 Units — Dollar Loss

Type of Construction	Fire Extending Beyond...		
	Area of Origin	Room of Origin	Fire Rated Compartment of Origin
Ordinary	$38,641	$61,099	$203,333
Wood Frame	22,208	33,462	99,777

When all units are considered, regardless of size, the following dollar losses result:

Table 6. 1978 CFIRS — All Units — Dollar Loss

Type of Construction	Fire Extending Beyond...		
	Area of Origin	Room of Origin	Fire Rated Compartment of Origin
Ordinary	$20,554	$30,504	$92,233
Wood Frame	19,784	27,657	53,290

The fact that the California data show a contrary trend moderates the claim of a direct relationship between type of construction and property dollar loss.

INJURIES — Life Safety Most Important Aspect of Analysis

The "Fire Protection Planning Report" indicates that the greatest concern about the effects of fire relates to life safety. If this is so, injuries and fatalities should receive the greatest emphasis in the analysis. While the data presented in the report do seem to indicate a relationship between construction type and injuries, two problems are encountered:

Inclusion of Firefighter Injuries Masks Relationship with Construction Type

First, and most important, injury data cited in the report include injuries to firefighters. This is true regardless of how the firefighter injury occurred. If a firefighter falls off a fire engine en route to a fire that spread beyond the area of origin, that injury is included. In a data base which may include as many as 57% firefighter injuries, a true relationship between injury data and construction type is masked.

The second problem is failure to include in the analysis all construction types. The "ordering" of construction types 5 through 8 can be shown — from least-to-greatest fire loss from injuries — as Type 5, Type 6, Type 7 and Type 8. These data alone appear to indicate a clear trend.

When all Data Considered, no Consistent Relationship Between Construction Type and Injuries is Found

However, when fire resistive and non-combustible construction are included in the analysis (Types 1, 3 and 4), the same logic would expect the order to be 1-3-4-5-6-7-8. But the "ordering" that actually results, in terms of least-to-greatest injuries from fire, is 1-5-3-6-7-4-8. This is hardly the consistent relationship claimed.

To more fairly evaluate the effect of construction type on injuries, the National Forest Products Association also looked at available NFIRS data for 1978. Included in this combined data base were 7,314 fire incidents in multifamily residences. Only injuries to persons *other than* firefighters were included. This is believed to be a more appropriate premise.

Table 7. 1978 NFIRS Data — National Forest Products Association

Type of Construction	Fires Spread Beyond Area of Origin			All Fire Spread		
	Injuries	Incidents	# per 100 incidents	Injuries	Incidents	# per 100 incidents
Fire Resistive	16	138	11.6	47	670	7.0
Protected Non-Combustible	12	46	26.1	23	239	9.6
Unprotected Non-Combustible	8	29	27.6	12	126	9.5
Protected Ordinary	69	521	13.2	108	1861	5.8
Unprotected Ordinary	67	427	15.7	109	1229	8.9
Protected Wood Frame	69	388	17.8	99	1335	7.4
Unprotected Wood Frame	132	668	19.8	183	1829	10.0

Again, the same pattern as that observed in the University of Maryland data emerges. If one limits analysis to construction Types 5 through 8, the "ordering" can be said to be Types 5-6-7-8. However, when all data are considered, the order becomes 1-5-6-7-8-3-4. Rather than claim that unprotected wood frame construction is safer than protected non-combustible construction, a more reasonable conclusion would be that no discernable pattern exists.

Statistical analyses can also be performed on the data to account for variations in the number of incidents within a construction type. At a confidence level of 95%, there is no statistical difference between any of the rates.

FATALITIES — Fatality Data Ignored

The "Fire Protection Planning Report" chose not to analyze fatalities because of a claim that the limited number of fatalities prevented "statistically meaningful analysis". This statement in itself suggests that no correlation exists between construction type and fatalities. However, it should be noted that "statistically meaningful analysis" is not dependent upon the number of fatalities, but upon the number of incidents in which a fatality may have occurred. The logic of the report's authors would suggest that if no fatalities occurred in one million fire incidents, then the result would not be statistically meaningful. It is suggested that since the number of incidents in which a *fatality* may have occurred is the same as those in which an *injury* may have occurred, the results are both meaningful and representative.

As reported in the University of Maryland report, fatalities per 100 fire incidents where the fire extended beyond the area of origin are shown in Table 8 below.

Fatality Data Available Indicate No Relationship Between Types of Construction and Fire Deaths

These rates indicate that no relationship exists between construction type and fatalities. *Life safety is considered the single most important factor in evaluating the effectiveness of building regulations. The absence of any trend suggesting a relationship between construction type and fatalities is persuasive support of the effectiveness and consistency of present code provisions.*

Table 8. 1978 NFIRS, University of Maryland Report

Type of Construction	Fatalities per 100 fire incidents	
	Over 20 units	All units
Fire Resistive	5.5	2.8
Protected Non-Combustible	8.2	7.3
Unprotected Non-Combustible	0.0	4.1
Protected Ordinary	2.4	1.8
Unprotected Ordinary	2.3	3.0
Protected Wood Frame	5.1	2.4
Unprotected Wood Frame	1.4	2.7

CONCLUSION

A full evaluation of fire record data shows no consistent ordering of construction types in terms of "fire safety". Further, no claim is made that wood frame is "better" than other types of construction. In fact, in many of the possible comparisons, it is not better. However, this concession is offset by many other comparisons — especially in buildings with more than 20 units — where wood frame construction performed better than other construction types. There are no clear trends to support the concrete and masonry industries' claim that construction type and fire losses are related.

The "Fire Protection Planning Report" compares only "ordinary" and wood frame construction types from analyzed NFIRS data. With only these four construction types to compare, it might appear in some cases that ordinary construction (masonry wall - wood floors and roofs) performed better than all wood frame construction. However, when fire resistive and non-combustible construction types are added, this "ordering" of construction is lost.

It should be noted that the U.S. Fire Administration, the funding source for the University of Maryland study, has stated that they do not necessarily agree with the conclusions and recommendations given in the final report. A disclaimer included in the report attests to this fact.

Fire Record Data Support Present Building Code Provisions

When all available data in the University of Maryland report are considered, it can be seen that no relationship exists between construction type and extent of fire spread, injuries, or fatalities. Indeed, these findings actually support the effectiveness and continuation of present code provisions as they relate to types of construction.

Table A1. Code for Extent of Flame Damage

NFIRS Code	Description
1	Confined to the object of origin
2	Confined to the part of room or area of origin
3	Confined to the room of origin
4	Confined to the fire rated compartment of origin
5	Confined to the floor or origin
6	Confined to the structure of origin
7	Extended beyond structure of origin
8	Not a structure fire
0	Extent of flame damage undetermined or not reported

Table A2. Comparison of Spread of Fire and Construction Type, 1978 NFIRS Data
No Detector Present

Type of Construction	Extent of Flamespread Cumulative % of Fire Incidents						
	Object	Area	Room	Compt.	Floor	Structure	Beyond
Fire Resistive	57	77	91	94	98	100	100
Heavy Timber	58	74	85	90	95	100	100
Prot. Non-Comb.	43	78	91	95	98	100	100
Unprot. Non-Comb.	49	75	89	95	99	100	100
Prot. Ordinary	46	69	85	89	95	100	100
Unprot. Ordinary	40	62	75	80	90	99	100
Prot. Wood Frame	43	69	80	85	93	100	100
Unprot. Wood Frame	37	59	74	77	87	99	100
Unknown/Other	51	73	89	90	99	100	100

Table A3. Comparison of Spread of Fire and Construction Type, 1978 NFIRS Data
Detector Working

Type of Construction	Extent of Flamespread Cumulative % of Fire Incidents						
	Object	Area	Room	Compt.	Floor	Structure	Beyond
Fire Resistive	63	84	97	97	100	100	100
Heavy Timber	100	100	100	100	100	100	100
Prot. Non-Comb.	57	79	86	100	100	100	100
Unprot. Non-Comb.	55	82	82	100	100	100	100
Prot. Ordinary	49	82	92	92	96	100	100
Unprot. Ordinary	44	75	90	94	98	100	100
Prot. Wood Frame	44	71	85	88	95	97	100
Unprot. Wood Frame	36	65	84	85	91	100	100
Unknown/Other	52	76	100	100	100	100	100

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